BONUS INSERT: GUIDE TO ASTRONOMY ACTIVITIES

ASTRONOMY®

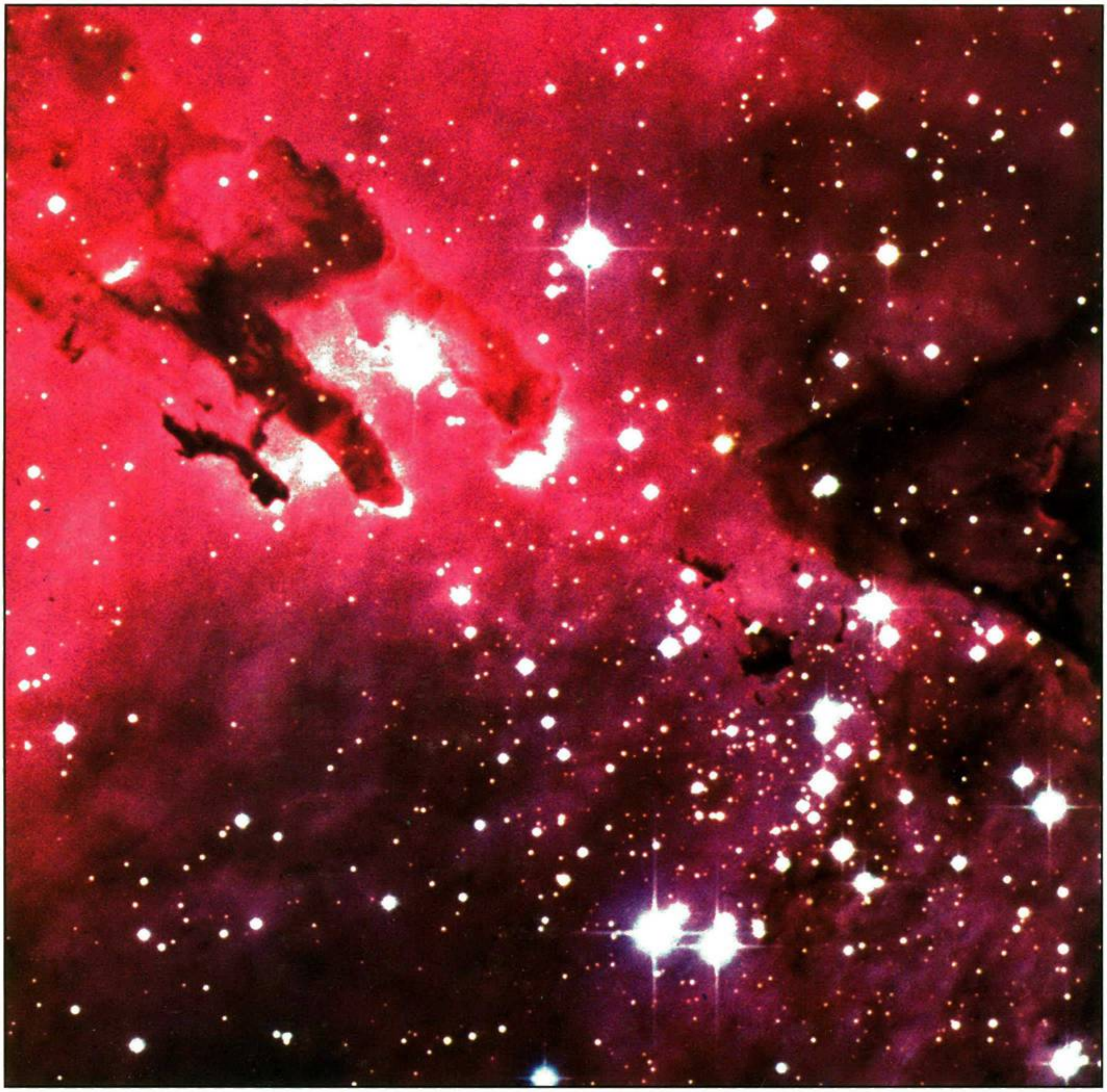
May 1992 U.S. $2.95
U.K. £1.75
Can. $3.50

TO THE EDGE: A MISSION TO PLUTO

Unfolding Mysteries of Sun-like Stars

Comet Halley's Meteoric Debris

ICD 08070



Eagle Nebula: Starlight and Dusty Gas

MEADE®

MEADE
152ED/APO SMC
MEADE ED APOCHROMAT U.S.A.
D=102mm
F=900mm f/9
MULTI-COATED
MEADE
102ED/APO SMC
Meade
LXD 600

Meade Model 102ED: 4" f/9 ED Apochromatic Refractor. Shown with optional #1664 Electronic Drive System.

Meade Model 152ED: 6" f/9 ED Apochromatic Refractor. Shown with optional #1697 Computer Drive/Slew System.

ED APOCHROMATIC REFRACTORS

The finest optical imaging performance obtainable, combined with the most advanced equatorial mounts ever made available.

Have you ever wished you could observe with an instrument that yields the finest, textbook-perfect star images obtainable from any telescope? *Now you can.*

Meade USA-made ED Apochromats combine absolutely uncompromised image quality with a level of equatorial mounting precision, stability, and sophistication heretofore only dreamed of by the advanced amateur. *If you're looking for the most nearly perfect, ultra high resolution, high-contrast images of the skies that astronomical instrumentation—of any type—can provide, then a Meade apochromatic refractor is for you.*

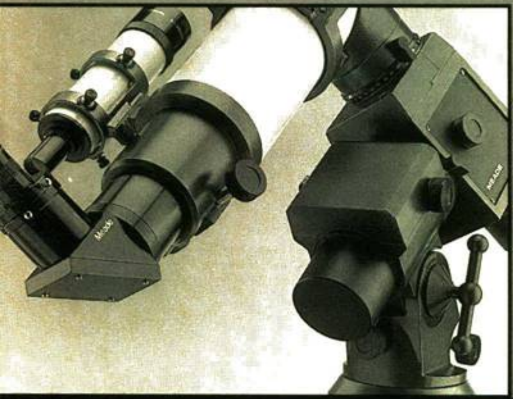
Optical Designs—Each 4", 5", 6", and 7" Meade apochromat includes an f/9 objective lens doublet with ED-glass (Extra-low Dispersion) rear element. Corrections for chromatic and spherical aberrations, for coma and astigmatism, and for lateral distortion are as faithful to optimized design criteria as can be obtained in any telescope. The front element of each objective is 2-side **Super Multi-Coated (SMC)** for maximum light transmission and image contrast.

Optical Tube Assemblies include the new Meade #684 giant rack-and-pinion focuser, with eyepiece-holders for both 1.25" and 2". The large 2.7" I.D. focuser sleeve permits the use of either 35mm or large-format professional camera bodies.

High-Contrast Baffling—Every Meade apochromat main tube includes a series of ***ten or more*** internal field stops and light baffles that effectively eliminate any stray light reaching the focal plane. Images of breathtaking sharpness, resolution, and contrast leap out against an extremely dark-sky backdrop.

Equatorial Mountings—As important to the serious observer as superb imaging performance, all-new state-of-the-art Meade LXD 600 and LXD 700 equatorial mountings will revolutionize forever the way amateur astronomers think about telescope mounting platforms. Consider:

- Massive polar and declination castings with oversize thrust surfaces.
- Worm-gear tracking and microfine manual slow-motion controls in both RA and Dec.
- *Eight* sealed ball bearings *(4 on each axis!)* carry even heavy loads with supreme precision.
- Superstable field tripods, including a new Meade Giant Field Tripod with 6" and 7" APO models.



MEADE
COMPUTER DRIVE SYSTEM
LX QUARTZ-DC SERVO MOTOR
SMART DRIVE
Current (mA x 100)
Focuser
Reticle
N S
On Off
Power 12 vDC
RS 232
Keypad
CCD
RA Motor
Encoders

Optional Electronic Drive Systems—Two new dual-axis, DC-servo-motor-controlled electronic drive systems are available for the LXD 600 and LXD 700 mounts; both drive systems fully integrate internally to either mount:.

■ ***#1697 Computer Drive/Slew System:***

Four dual-axis drive speeds for (a) photoguiding corrections (at **2x** sidereal rate); (b) image centering and microslewing in the main telescope (at **32x** sidereal rate); (c) image centering in the viewfinder (at **2° per second**); and fast-slewing of the telescope across the skies (at **8° per second**). Use the keypad controller to switch speeds instantly as you move the telescope electronically with a pointing accuracy never before available.

Permanently programmable (PPEC) Smart Drive™ capable of reducing RA periodic drive errors to 5 arc secs. or less.

Digital Readouts on both telescope axes, read from the handheld Electronic Command Center.

GO TO Capability: Enter the RA and Dec of an object, punch GO TO, and the telescope automatically slews on both axes at 8° per second to the object, centering it in the field.

747-Object Built-in Library: Enter any of the 110 Messier objects, 278 of the finest NGC objects, 351 stars (doubles, variables, polar alignment stars), or one of the 8 major planets from Mercury to Pluto; punch GO TO, and the telescope automatically slews to the object. For $99* add the optional Meade 8000-object CNGC library to the software (a 30-second plug-in).

Keypad operation of virtually every telescope function, from tracking rates to the crossline brightness of an illuminated reticle eyepiece.

Polar alignment of the Mount: Quick (less than one minute) and precise, using the 2-star method.

■ ***#1664 Electronic Drive System***—For users not requiring the microprocessor-controlled capabilities of the #1697 Computer Drive, the #1664 system includes 2 dual-axis drive speeds (**2x** and **32x**); permanently programmable (PPEC) Smart Drive; object tracking-rate control, including quartz-controlled sidereal rate; and other features.

Complete ED Apochromatic Refractors

Specifications—Each complete telescope includes: optical tube assembly with #684 giant 2.7" focuser, 8 x 50mm viewfinder, #930 2" diagonal mirror with 1.25" adapter, and Super Plössl 26mm eyepiece; 4" and 5" models include the LXD 600 equatorial mount and standard field tripod; 6" and 7" models include the LXD 700 equatorial mount and giant field tripod; each mount is provided with manual slow-motion controls, analog setting circles, and locks on both axes.

Special Introductory Pricing Through 5/31/92*:

Model 102ED:	4" f/9 ED/APO complete	**$1795.**
Model 127ED:	5" f/9 ED/APO complete	**2295.**
Model 152ED:	6" f/9 ED/APO complete	**3995.**
Model 178ED:	7" f/9 ED/APO complete	**4995.**

Drive Systems

#1664 Electronic Drive System	**$295.**
#1697 Computer Drive/Slew System	**595.**

Optical Tube Assemblies (OTA's)

Each OTA includes complete tube assembly with #684 giant 2.7" focuser. Supplied without viewfinder or accessories.

Model 102ED/APO-OTA:	4" f/9	**$1075.**
Model 127ED/APO-OTA:	5" f/9	**1595.**
Model 152ED/APO-OTA:	6" f/9	**2295.**
Model 178ED/APO-OTA:	7" f/9	**2995.**

Equatorial Mountings

LXD 600 Mount & Standard Field Tripod	**895.**
LXD 700 Mount & Giant Field Tripod	**1995.**

■ *Prices shown are suggested USA mail-order retail prices and do not include sales taxes or shipping, if applicable.

■ The 1992 Meade General Catalog—$3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.

■ **For further information on Meade ED Apochromatic or Schmidt-Cassegrain telescopes, or on any Meade product, call Meade Instruments toll-free at 1-800-854-7485 (in Calif. 714-556-2291), or contact one of these authorized mail-order dealers:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE COMPANY, Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-878-9577; Info.: 510-447-9570.

SCOPE CITY/Mail-Order Dept., Simi Valley, CA.
Orders: 800-235-3344; Calif. & Info: 805-522-6701

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Illinois & Info.: 312-332-2000.

Canada:
KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

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World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
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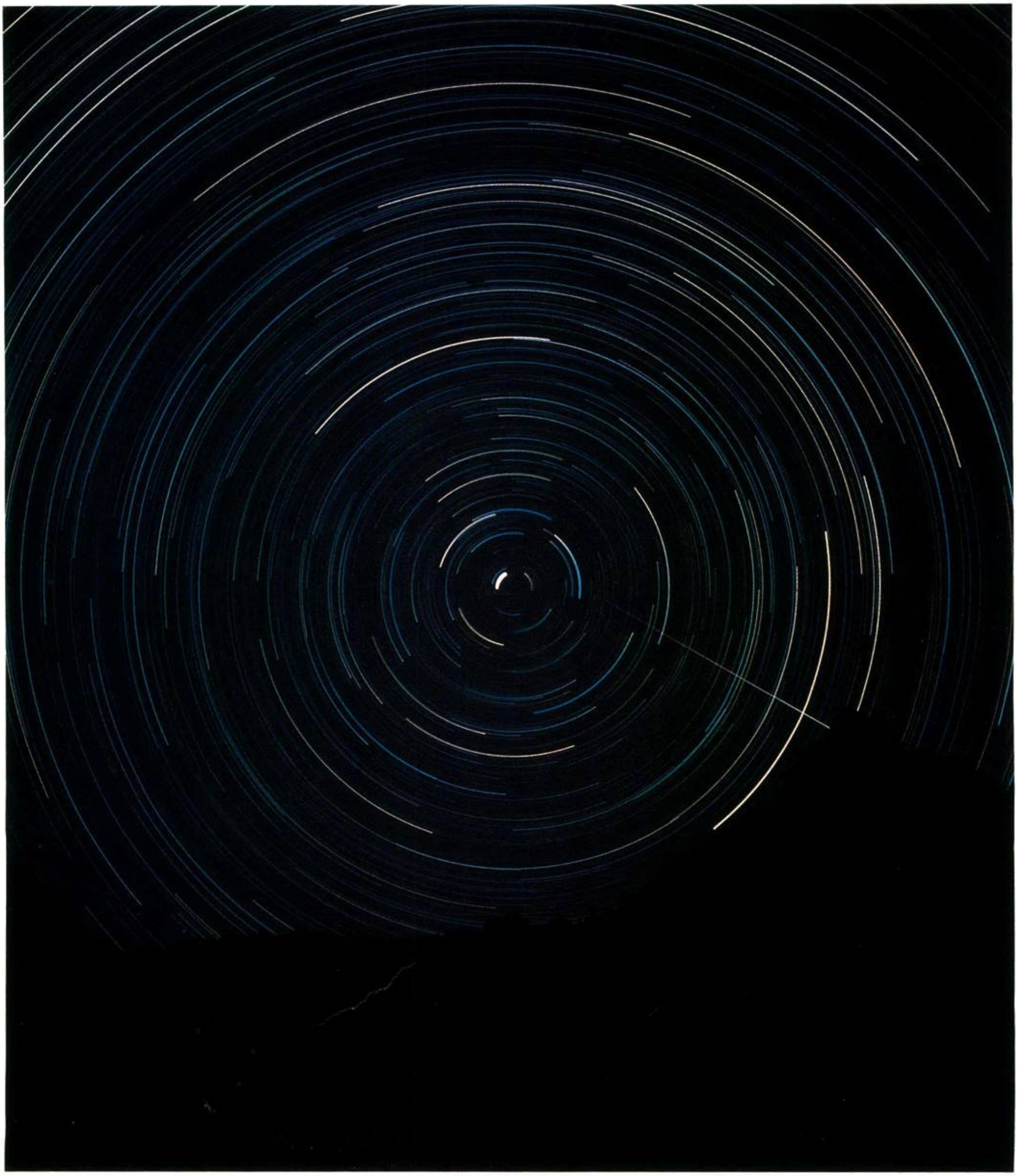
COVER: A summer delight for astronomers, the Eagle Nebula (M16) in Serpens is visible even in binoculars and appears in small telescopes as a fuzzy glow peppered by stars. For more on warm weather sights, see Sky Almanac. Photo copyright 1986 Anglo-Australian Telescope Board.

STARS TRAIL around the celestial pole while a meteor streaks across the sky. This month we tell you how to align your telescope to the celestial pole (page 68) and how to watch this month's Eta Aquarid meteor shower (page 78). Photo by Skip Drew.



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The Audit Bureau

Behind the Scenes

ASTRONOMY SUMMER BEGINS

Of course, summer doesn't *really* begin in the Northern Hemisphere until the solstice on June 20th. But for many amateur astronomers, astronomical summer kicks off with Astronomy Day, which is held this year on May 9th.

Astronomy Day is a time when all across the United States and Canada, clubs and groups of astronomers take to local street corners, shopping malls, and cable TV outlets, making a big push to bring astronomy into the lives of ordinary people.

Perhaps you've seen their displays in years past. Maybe you're one of those who lingered at the table and peered through a scope aimed at the far end of the mall. Or maybe you've actually helped run such an exhibit. In any case, I think we'll agree that club members and their activites are doing a fantastic job of helping introduce newcomers to the hobby.

If you're like many of us, you got started in the hobby with the help of someone who was already knowledgeable about astronomy. It might have been a learn-the-stars group that met at a nature center, or perhaps someone kindly lent you a few books after you spent an enthralling evening looking at wonders through a telescope. Whatever it was, that encounter with astronomy probably changed your life.

Is this the year for you to help repay that debt? I'll bet there's a club nearby that could use some help in spreading the word about astronomy this summer. Give them a call. If you're not sure whom to contact, turn to the special directory bound into this issue. The list was compiled by Associate Editor Alan Dyer, who polled all the astronomy clubs and organizations we know about in North America.

Nor does the excitement end when Astronomy Day passes. All during summer and into autumn, star parties, meetings, and conventions of amateur astronomers will be going on across North America. (See our list starting on page 18.) If you're like many folks who'll be out traveling on vacation this summer, pay a visit to one of the planetariums and observatories in the directory. They all welcome visitors, and you'll be assured of a trip that goes well out of the ordinary.

Last but certainly not least, all of us here at ASTRONOMY hope to see many of you in Madison, Wisconsin, on June 20th and 21st. We'll be cosponsoring the Astronomical Society of the Pacific's *Universe '92 National Astronomy Expo and Conference*. I hope you'll be able to make it there too. For details, see the notice on page 96.

Sincerely,

Robert Burnham
Editor

P.S. By the way, many thanks to the clubs, planetariums, and organizations that responded so promptly to our survey. If we overlooked you this year, please send us up-to-date information right away so we can include you in the directory next time.

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Letters

Efforts in Astronomy Education

Many efforts in astronomy education are underway across the country. Project STAR addresses the issues of secondary education and sponsors summer institutes for teachers. The Lawrence Hall of Science developed planetarium activities for use with Starlab portable planetariums, which are found in many school districts and city museums. My planetarium (part of the Kansas City school district) disseminates an earth and space science curriculum for elementary grades (called Project STARWALK) that combines classroom lessons with planetarium lab activities.

You can help strengthen astronomy education by telling the teachers at your local school about these programs and encouraging them to contact a local planetarium or museum about a field trip. — *Bob Riddle, Planetarium — Project STARWALK, 6512 Wornall Road, Kansas City, Missouri 64113*

— Contact Project STAR at the Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138 and Planetarium Activities for Student Success at the Lawrence Hall of Science, University of California, Berkeley, CA 94720.

At least 240 high schools in this country offer oceanography, meteorology, and navigation as part of their Naval Science curriculum. The third year of the Navy Junior Reserve Officers Training Corps (ROTC) program includes an astronomy course. The Junior ROTC program started in schools in 1967 and uses retired naval officers and chief petty officers as instructors. — *Lt. Comdr. Arthur C. Friedman, USN (ret.), Columbus, Ohio*

Another Solar System Model

Amateur News in the February issue describes a solar system model built by the Boise Astronomical Society. The article mentioned that BAS members knew of only two other models built to realistic scales for both planetary distances and sizes.

I am happy to report that a third model exists at the Centre d'Interprétation Scientifique du Témiscouata in St.-Louis-du, Quebec. While working there, I helped construct a 1:10,000,000,000 scale model of the solar system. Planets were painted on placards, complete with known satellites. Detailed artwork was possible only for the Sun and giant planets.

Walking along the length of the

Genesis Owner Turned Into Zombie!

Gentlemen:

I would like to say a few words about my new Genesis. I live in a relatively light polluted area, and own an 8" SCT which I have used for about two years. During this time there have been many deep sky objects which I have been unable to locate from my back yard.

I bought Genesis because I wanted a telescope that I could set up quickly to use at home on week-nights. When I began using Genesis, a few weeks ago, I was surprised to find many objects that have eluded me during the past two years. I was even more surprised when I realized that I had been looking in the right places all the time. These objects showed up in Genesis, but not in my 8" SCT.

My back yard experience with Genesis encouraged me to take it to my dark sky observing site which is, at an elevation of 5000 feet above sea level, in the Sierra Nevada Mountains. What I saw there was, in many cases, better than photographs in magazines. I was able to resolve globular clusters to a greater degree than publications indicate.

I didn't expect Genesis to be this good. It really is better than I imagined.

There does seem to be one problem with Genesis. My short week-night observing sessions have become anything but short, and I frequently arrive at work feeling and looking very much like a zombie. I guess that no telescope can solve all of your problems. In any case, thanks for the ones you did solve.

- George N. Storm, California

Photo by Jim Riffle

Unsolicited comments from warranty cards

- *It's beautiful, from case to scope.* C.C. The Netherlands
- *Fantastic! Great photo resolution, best optics ever owned and I'm a Hasselblad & Nikon fan. Now my best item.* D.B. New Jersey
- *This is my 1st scope and I'm having a wonderful time finding the limits of the instrument and my locating abilities.* G.P. New Jersey
- *Very pleased with your new improvements.* J.F. California
- *Even though cost was more than an 8" SCT with mount, quality & convenience won out. I will only use Tele Vue optics, mount and accessories.* W.B. Indiana
- *The telescope lives up to its expectation.* T.W. England
- *Wanted a 2nd telescope that was portable, delivered wide fields and superb images. Genesis is all I hoped for. The sharpness is astonishing and it's very portable.* G.H. Canada
- *Sold my 8" SCT looking for better images.* P.F. New York
- *Fantastic! My wife could not see Trapezium etc. with old scope. Now can't get her away from eyepiece: you have right to be enthused about your product.* W.J. Canada
- *I just wanted to have one excellent telescope to do astrophotography. Fantastic. Awesome.* J.J. California
- *Beautiful equipment - Total satisfaction with first use. Keep up the good work.* M.C. Ohio
- *I wanted a very high quality refractor. I was told by many - "This is it." This is a beautiful instrument!* M.F. Florida
- *Remarkable! I always wanted a 4" fluorite refractor. Sold my (8" SCT).* T.S. Indiana
- *Compactness & quality - a beautiful, fantastic instrument.* J.V. The Netherlands

- *It's the best 4" refractor made.* A.A. California
- *I was looking for the best first telescope I could buy. Something small. I never saw images clearer and more distinct than in Genesis.* G.D. Canada
- *Genesis is the only scope in the race. I wanted the best and believe I got it.* E.S. Australia
- *As the apparent equal of a (Maksutov), with the added RFT capability, Genesis is 'the', to me, obvious choice for portable astronomy. I'm completely satisfied.* R.A. Georgia
- *Very Impressive - my first view was of Pleiades with a 40mm Wide Field. The observation was remarkable, crisp, bright and jewel-like.* P.L. Massachusetts
- *The best on the market.* E.B. England
- *I bought this telescope without having seen it in-person, based on its specification & your reputation for quality. As usual, I got more than I expected with Tele Vue products...* K.L. Texas
- *My friend borrowed it & won't give it back!!* T.L. Canada
- *I wanted portability and very high quality optics. I have waited many years to be able to afford this telescope, - it was worth waiting for.* P.H. Australia
- *Superior to other 4" scopes on offer.* Z.V.S. South Africa
- *Had SCT, poor contrast/resolution. Tele Vue just the opposite, also it's more portable.* W.S. Connecticut
- *I purchased this instrument because:*
  1) Apo-refractor - basic design
  2) Tele Vue reputation
  3) Dealer owns same model
  U.B. Canada
- *Genesis is as good as gold...Maybe better!* F.G. California
- *I compared specs of Tele Vue vs (other high performance refractors); T-V best choice for $.* R.A. New Hampshire
- *Magic.* C.H. England

My sincerest thanks to all who've written us with such kind comments. I look forward to reading yours.

Al Nagler

Tele Vue

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Pearl River, NY 10965
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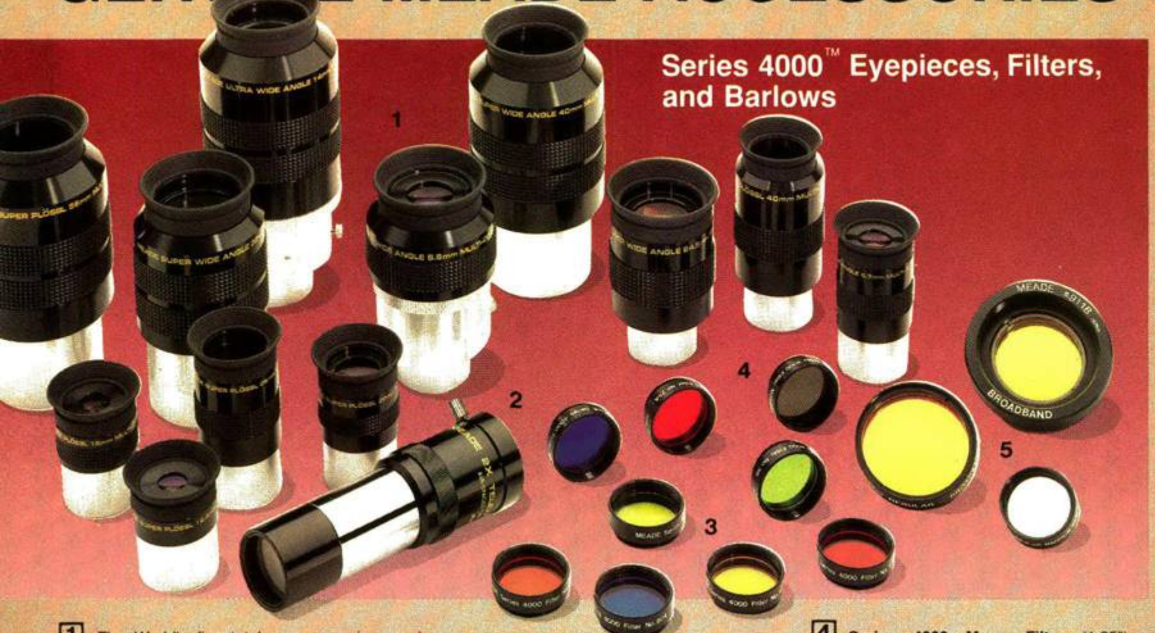
GENUINE MEADE ACCESSORIES & PARTS

Series 4000™ Eyepieces, Filters, and Barlows



1 The World's finest telescope eyepieces now include rubber grips and soft rubber eyeguards for an even better observing experience! All eyeguards fold down for eyeglass wearers—a feature not available on competing brands. Best of all, **Meade Series 4000's are guaranteed to deliver more field, more contrast, and more image sharpness than any other brand at any price, or your money back.*** For splitting the closest doubles, revealing tenuous, faint nebulosity in deep-space, or studying hairline lunar and planetary detail, Meade multi-coated Series 4000's are the oculars that serious observers insist upon. ***"Clearly the best."***

Super Plössls (5-elements; 1.25"; 52°):
6.4; 9.7; 12.4; 15; 20; 26mm ea **$79.95** (2.49)
32mm(52°); 40mm(44°); each **99.95** (2.49)
56mm (52°, 2") **219.95** (3.18)

Super Wide Angles (6-elements; 1.25"; 67°):
13.8mm: **129.95** (2.49) 18mm: **139.95** (2.49)
24.5mm: **159.95** (2.49) 32mm(2"): **229.95** (3.18)
40mm(2"): **279.95** (3.18)

Ultra Wide Angles (8-elements, 1.25"; 84°):
4.7mm: **147.95** (2.49) 6.7mm: **187.95** (2.49)
8.8mm(1.25"/2"): **219.95** (3.18)
14mm(1.25"/2"): **249.95** (3.18)

*at participating dealers; see catalog for details.

2 **#140: Series 4000 2x Apochromatic Barlow Lens** (1.25")--The original Meade 3-element, air-spaced, multi-coated design. Absolutely unmatched in image resolution and color correction. 28mm dia. lens (26mm clear aperture). **$69.95** (2.49)

3 **Series 4000 Photo-Visual Color Filters** (1.25")—Made of purest crown optical glass, dyed in the mass. For increased contrast on the Moon and planets. Thread into virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow-Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue. each **$12.95** (1.79)

Set #1—4 filters: #12 Yellow, #23A Lt.Red, #58 Green, #80A Blue **$42.95** (2.49)

Set #2—4 filters: #11 Yellow-Green, #25A Red, #47 Violet, #82A Lt. Blue **$42.95** (2.49)

Set #3—4 filters: #8 Lt. Yellow, #21 Orange, #38A Dark Blue, #56 Lt. Green **$42.95** (2.49)

Sets #1 & #2—8 filters **$82.95** (2.49)

Sets #1, #2, & #3—12 filters **$118.95** (3.18)

4 **Series 4000 Moon Filter** (1.25")—Excellent for 4" to 12" telescopes. Reduces Moon brightness by 87%. **$14.50** (2.49)

5 **Series 4000 Nebular Filters**—The very latest in multi-layer interference coating technology, Meade premium nebular filters are guaranteed to be the finest obtainable at any price. Use a Series 4000 Broadband filter to block most forms of light pollution, with minimal attenuation of desired wavelengths. Use a Narrowband filter in heavily light-polluted areas, or for extremely high contrast observing of faint nebulae.

BROADBAND FILTERS

#908B (1.25")—Threads into all Meade 1.25" eyepieces, and virtually all other brands. Full 26mm clear aperture. **$67.95** (1.79)

#910B—Threads into all Meade 2" eyepieces and most others; 44mm dia. **99.95** (2.49)

#911B--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **87.95** (1.79)

NARROWBAND FILTERS

#908N (1.25")—Threads into virtually all 1.25" eyepieces; 26mm clear aperture. **89.95** (1.79)

#910N—Threads into all Meade 2" eyepieces and most others; 44mm dia. **119.95** (2.49)

#911N--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **109.95** (2.49)

World's Most Advanced Illuminated Reticle Eyepiece

Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Internal batteries included. Multi-coated optics. Bullseye reticle. 1.25" **$119.95** (2.79)

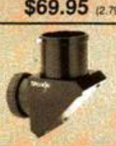
Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator. **$99.95** (2.79)

MA 12mm Illuminated Reticle Eyepiece

Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Includes wireless red LED illuminator with internal batteries and variable brightness control. **$89.95** (2.79)

MA 12mm-Same as above, but with cord and plug for Meade telescopes with power panels, in place of wireless illuminator. **$69.95** (2.79)

2" Diagonal Mirror



#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory; with 1.25" eyepiece adapter **$89.95** (2.79)

Camera Adapters (1.25" & .965")

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-Mount, available separately.

.965": **$24.95** (2.49) 1.25": **$29.95** (2.49)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-Mount for your camera. **$39.95** (2.49)

Tele-Extenders

For Eyepiece-Projection photography with any Meade or Celestron SCT. Threads on to eyepiece-holder. Use with T-Mount for your camera.

Basic Tele-Extender: *(above)* Fixed projection power; use with eyepiece for lunar and planetary photos. **$26.95** (2.49)

Variable Tele-Extender: Sliding cell, with lock, permits wide range of projection magnifications with the same eyepiece. **$36.95** (2.49)

T-Adapters for SCT's

For Prime Focus photography with any Meade or Celestron SCT. Use with T-Mount for your 35mm camera. **$26.95** (2.49)

2X Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25" **$47.95** (2.49)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25" **$59.95** (2.49)

Orthoscopic Eyepieces (1.25")

Fine 4-element oculars that yield excellent image quality with any telescope. Computer-optimized design provides wide, flat fields, highly corrected for spherical and chromatic aberrations. Parfocal, multi-coated. 1.25" barrels. Threaded for filters. **Focal Lengths: OR 4, 6, 9, 12.5, 25mm.**

each **$47.95** (2.49)

Modified Achromatic Eyepieces

An improvement on the traditional Kellner design, the 3-element MA gives sharp, faithful, well-corrected images of the Moon, planets, and deep-space. Multi-coated; threaded for filters. 1.25". **Focal Lengths: MA 9, 12, 25, 40mm.**

each **$37.95** (2.49)

Rack-and-Pinion Focusers (1.25")

The finest focusers in the industry. Meade rack and pinion mechanisms have precise, ultra-smooth action along the entire travel distance. Housings are machined for tight fit of the moving sleeve. All focuser models may be used on tubes of from 4" to 20" diameter; all accept 1.25" eyepieces. Mounting hardware included.

#71—The finest economical focuser available. Travel distance: 2.2" A precision mechanism, beautifully finished. **$44.95** (2.49)

#67—Includes spring-loaded gearbox for variable tension adjustment. Travel distance: 2.2". **59.95** (2.49)

Rack-and-Pinion Focusers (2")

#680—The most popular 2" focuser ever manufactured. Thousands in use. Spring-loaded gearbox; 3" travel. Includes 1.25" and 2" eyepiece-holders. **89.95** (3.48)

#682—Low-profile 2" focuser; body height only 1.75". Spring-loaded gearbox. Travel: 2.5". Includes 1.25" adapter. **99.95** (3.48)

Viewfinders: 30mm, 50mm, 60mm

#637: 6 x 30mm-Fine, 7° wide-field finder; coated, achromatic lens; crosshair eyepiece. 2-ring bracket with alignment screws. Attaches to tube diameters 6" to 12" **$39.95** (2.79)

#545: 8 x 50mm- *(lower photo)* Wide 5° field; coated achromatic objective; crosshair eyepiece. White tube. Ideal for telescopes of any aperture. See bracket below. **59.95** (3.48)

#544: 8 x 50mm– Same as #545, but in Meade blue. **59.95** (3.48)

#957: 9 x 60mm— *(top photo)* Collects 44% more light than 50mm; superior for faint objects; bracket below. **89.95** (3.78)

Bracket for 8 x 50mm: Fits Meade and Celestron SCT's, and other tubes from 7" to 20" diameter. **17.95** (1.79)

Bracket for 9 x 60mm: Fits tubes from 7" to 20" diameter. Removable dovetail included. **22.95** (1.79)

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Superb, fully multi-coated 11 x 80mm and 20 x 80mm Giant Binoculars, ideal for wide-field deep-space observing. **Rubber-coated bodies for rugged field use!** BAK-4 prisms yield bright, sharp, high-contrast images. Hard carry case, tripod adapter included.

11x80: **$359.95** (4.87)
20x80: **$379.95** (4.87)

45° Erect-Image Diagonal Prisms

Originally developed by Meade Instruments, these convenient diagonals erect the astronomical image, for terrestrial use of astronomical telescopes. Fully coated.

#927: for .965" focusers.
#928: for 1.25" focusers.
#931 Hybrid: accepts 1.25" eyepieces, fits .965" focusers.

Specify model desired. each: **$49.95** (2.49)

HOW TO ORDER

- Prices shown are suggested USA mail-order retail prices and do not include any applicable sales taxes.
- Suggested shipping and handling charges to the 48 states by UPS or US Mail shown in ( ) next to each price.
- Meade accessories may be ordered from any Meade Advanced Products dealer. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE CO., Burbank, CA
Orders: 800-843-4780; Info: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828. Info: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-878-9577. Info: 510-447-9570.

SCOPE CITY/Mail-Order, Simi Valley, CA.
Orders: 800-235-3344; Info/CA:805-522-6701

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Info/IL: 312-332-2000.

Canada:

KHAN SCOPE CENTRE , Toronto, Ontario.
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Complete 6", 8", and 10" telescopes with equatorial mounts, motor drives, setting circles, and full accessorization... from **$499.95!**

6" f/8 $499.95

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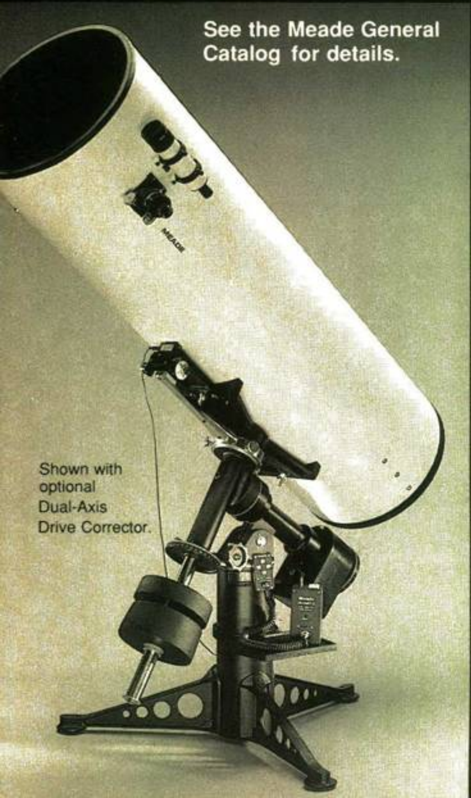
Starfinder 16: 16" f/4.5 $1995.

See the Meade General Catalog for details.



Shown with optional Dual-Axis Drive Corrector.

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- **Superb Optical System:** Includes a Meade hand-figured parabolic primary mirror that meets the theoretical limit of resolution for its aperture, with matching elliptical flat secondary mirror. Both mirrors multi-coated and made of fine-annealed Pyrex® glass.

- **Precision Equatorial Mount:** Manufactured of virgin aluminum castings machined to tolerances of .001" or better, and placed atop a 4"-dia. pier with die-cast tripod legs, yielding rock-solid support for the optical tube assembly. The telescope moves effortlessly from object-to-object on precision bearing surfaces. Polar and declination shafts are 1" solid steel. Setting circles on both axes facilitate the location of faint sky objects directly from their catalogued coordinates.

- **Electric Motor Drive** (115v./60Hz) with 6 ft. power cord: Permits fully automatic tracking of celestial objects; plugs into any standard outlet.

- **Accessories and Components:** Meade Starfinder telescopes include high-performance components throughout: **#71 Rack-and-Pinion Focuser** (1.25") for smooth, backlash-free focusing of the image; a coated achromatic **#637 6 x 30mm Viewfinder** with crosshair eyepiece and 7° field, for quick object-locating; **coated MA 25mm** (1.25") eyepiece; strong, durable spiral-wound **optical tube** with attractive white finish; and **cast aluminum mirror cell** for accurate mounting and alignment of the primary mirror.

- **Optional Accessories:** See the opposite page for some of the many optional accessories available. Additional systems, including the **#55 Manual Declination Control**, **#43 Drive Corrector** and **#47M Dual-Axis Drive Corrector,** are described the **Meade General Catalog.**

A Meade Starfinder telescope opens up the skies to an extremely wide range of serious visual observing, to lunar and planetary photography, and even to limited deep-space photography. And every telescope is backed by the World's largest manufacturer of serious telescopes.

- **Packing & UPS Shipping Charges to any address in the 48 states: 6"--$50; 8"--$60; 10"--$75.**

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- **The 1992 Meade General Catalog—$3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.**

- **For further information call Meade Instruments toll-free at 1-800-854-7485 (in Calif. 714-556-2291) or contact one of these authorized mail-order dealers:**

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Orders: 800-422-7876; Info.: 405-364-0858.

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Orders: 800-843-4780; Info.: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
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ADVANCED PRODUCTS DIVISION **Meade Instruments Corporation**

LX200 SCHMIDT-CASSEGRAINS

Legendary Meade SC optics and the largest, most rigid, most advanced fork mounts in commercial Schmidt-Cassegrain history.

Now you can buy the most advanced 8" and 10" Schmidt-Cassegrains ever produced, at a price directly competitive with other SCT's offering only a fraction of the features!

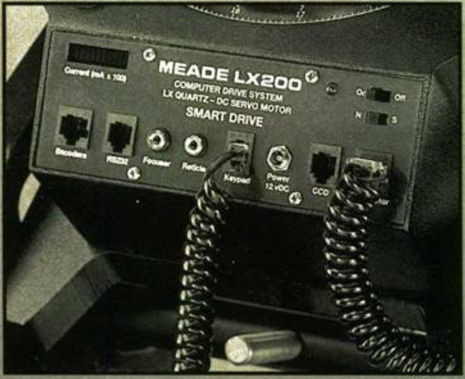
Meade LX200 SCT's offer a revolutionary departure from any other SCT's ever made available. Consider the **standard specifications** of these telescopes:

New Heavy-Duty Fork Mounts—The largest, most rigid in the industry. *Meade 8" and 10" LX200 fork mounts yield the lowest damping times of any SC fork mounts available.* Large 4"-diameter polar ball bearings complemented by DC-servo-motor-driven worm gears on ***both*** telescope axes permit observatory-level precision in tracking, guiding, and slewing.

100% Computer-Controlled Operation—All-new Meade LX200 microprocessor-controlled drive systems offer an incredible array of features:

■Four-speed operation on both telescope axes simultaneously, including (a) photo-guiding (at **2x** sidereal rate); (b) image centering and microslewing in the main telescope (at **32x** sidereal rate); (c) image centering in the viewfinder (at **2**° per sec.); or fast-slew of the main telescope across the skies (at **8**° per sec.).

■Pushbutton Electric Slew—Press RA or Dec slew, east or west, north or south, and the telescope moves at 8° per sec. on both axes. As you near a desired object, flip to 2° per sec. slew, to center the object in the field. The observer need never touch the telescope in moving from one object to another. (Of course, if you wish, the telescope may be moved manually as well.)



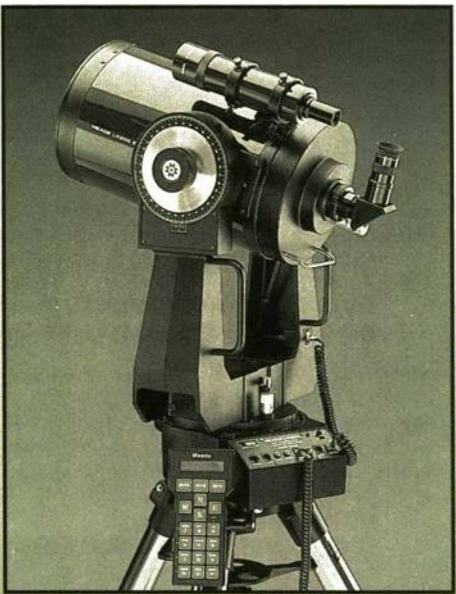
■Digital Readouts on both axes, read from the handheld Electronic Command Center (ECC).

■GO TO Capability—Enter the RA and Dec of an object into the keypad of the ECC, press GO TO, and the telescope automatically slews to the object at 8° per sec., centering it in the field.

■747-*Object* Built-in Library—Enter any of the 110 Messier objects, 278 of the finest NGC objects, 351 stars (doubles, variables, polar *reference stars*), or one of the 8 planets, from Mercury to Pluto, press GO TO, and the telescope slews at 8° per sec. to the object with uncanny precision. For $99* add the 8000-object Meade CNGC library, a 30-second plug-in.

■Permanently programmable (PPEC) Smart Drive™, capable of reducing periodic drive errors to 5 arc. sec. or less.

Legendary Meade Super Multi-Coated f/6.3 or f/10 Schmidt-Cassegrain Optics—Now you can choose either wide-field f/6.3 or classical f/10 Meade US-made SC optics **at the same price.** Either way, you'll be buying the finest Schmidt-Cassegrain optical system available, a system that yields razor-sharp stellar images and high-resolution observing of the Moon, planets, and deep-space, from the World's leading manufacturer. Meade exclusive Super Multi-Coatings on both sides of the correcting plate assure maximum light transmission and contrast.



Altazimuth Mode Operation—For all visual observing applications, and for lunar and planetary photography, Meade LX200's may be set up in the altazimuth mode, without any equatorial wedge—just attach the telescope's drive base directly to the tripod, use the fast 1-star alignment procedure, and the telescope's computer actuates 2-axis tracking that keeps objects precisely centered in the field, even at high powers, during the entire observing session. For long exposure photography (longer than about 5 minutes) altazimuth-induced field rotation requires an equatorial wedge, which may be purchased separately.

Fast Polar Alignment—Center two reference stars in the telescopic field and the telescope's computer tells you exactly what telescope controls to actuate for precise polar alignment in the equatorial mode in less than a minute.

The widest array of keypad and power-panel control functions—In addition to the microprocessor-controlled operations listed above, the handheld ECC and the telescope's power panel permit: readout of sidereal or local time; actuation of the optional electric focuser; crossline brightness control of an illuminated reticle eyepiece; direct plug-in of popular CCD autoguiders/imagers; and more than 14 other telescope functions.

MEADE LX100 SCHMIDT-CASSEGRAINS

Observers not requiring the sophistication of the LX200 electronics may wish to consider an 8" or 10" LX100 model SCT instead. Meade LX100's include the exact same heavy-duty fork mounts of their LX200 counterparts, but with a microfine declination tangent arm control in place of the LX200's motorized worm gear, and with a 2-speed drive in place of the LX200's 4-speed drive; optical tubes and coatings are identical. Standard LX100 features include:

■ Handheld Electronic Command Center—With 2-speed operation, **2x** for photo-guiding and **32x** for image centering and microslewing in the main telescope. (With the optional DC-servo declination motor installed, these speeds are operational on both telescope axes.)

■ Permanently programmable (PPEC) Smart Drive, as described above.

Complete LX100 and LX200 Telescopes

Specifications: 8" and 10" LX200's—Each complete telescope includes: 8" or 10" SC optical tube assembly (specify f/6.3 or f/10) with super multi-coatings; heavy-duty fork mount, with 4" polar ball bearing, dual-axis 5.75" worm-gears, and multi-function power panel display on the drive base; manual slow-motion controls on both axes; handheld keypad Electronic Command Center, with digital readout display, PPEC Smart Drive, four-speed drive control on both axes, GO TO controller, and 747-object software library; 25 ft. power cords for telescope operation from either 12 v. DC auto cigarette lighter plug or 115v.AC; 8 x 50mm viewfinder with crosshairs; diagonal prism (1.25"); Series 4000 Super Plössl 26mm eyepiece; variable-height field tripod; new deluxe die-cut-foam-fitted carrying case; complete operating instructions.

Specifications: 8" and 10" LX100's—Each complete telescope includes 8" or 10" SC optical tube assembly (specify f/6.3 or f/10) with super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, 5.75" RA worm gear, and multi-function power panel display on the drive base; manual slow-motion controls on both axes; handheld pushbutton Electronic Command Center with PPEC Smart Drive and 2-speed drive control; 25 ft. power cords for telescope operation from either 12v. DC auto cigarette lighter plug or from 115v. AC; viewfinder: 6 x 30mm (8") or 8 x 50mm (10"); diagonal prism (1.25"); Series 4000 Plössl 26mm eyepiece; variable-height field tripod; equatorial wedge (8") or Superwedge (10"); new deluxe die-cut-foam-fitted carrying case; complete operating instructions.

Special Introductory Pricing Through 5/31/92*:

Supplied complete, per above specifications:

8" LX200 Schmidt-Cassegrain	**$1995.**
Equatorial Wedge 8"	**110.**
10" LX200 Schmidt-Cassegrain	**2295.**
Superwedge 10"	**395.**
8" LX100 Schmidt-Cassegrain with wedge	**1695.**
10" LX100 with Superwedge	**2395.**

■ *Prices shown are suggested USA mail-order retail prices and do not include sales taxes or shipping, if applicable.

■For dealer or catalog information see the Meade **ED Apochromatic Refractor** ad in this issue.

ADVANCED PRODUCTS DIVISION

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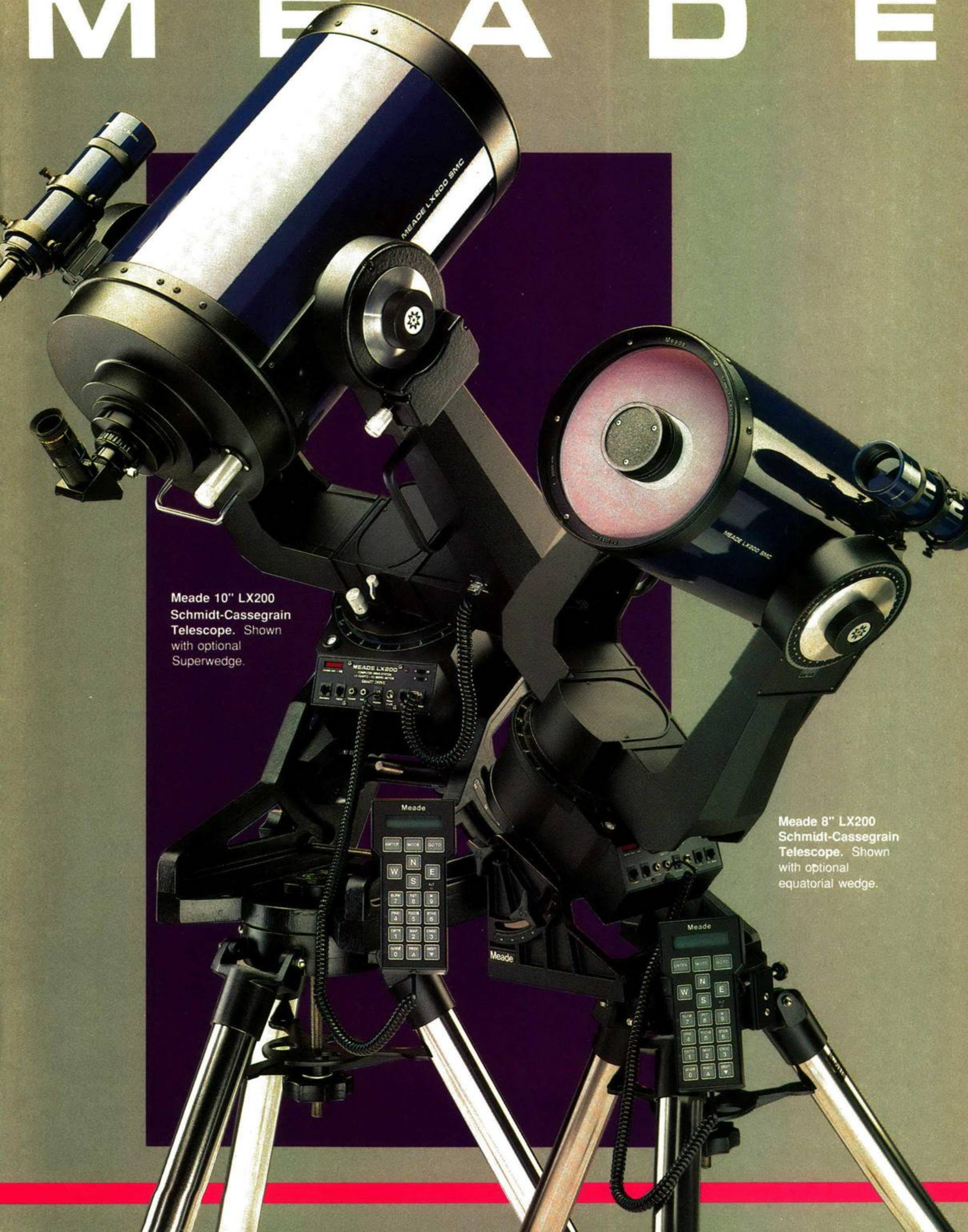
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Meade 10" LX200 Schmidt-Cassegrain Telescope. Shown with optional Superwedge.

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model with a group of students helped drive home the immense distances entailed within the solar system. Because this educational tool is so appreciated by students, I think more such models should be built. — *Daniel Thibault, Ottawa, Ontario, Canada*

The Brightest Star

James Kaler in "The Brightest Stars in the Universe" in the May 1991 issue states that HD 93129A is the most luminous star known. If this star is an O3 supergiant, the star must have been even hotter when it was on the main sequence. What was its spectral type then? — *Roberto Pellanda, Porto Allegre, Brazil*

— Presently, spectral types end at O3 since astronomers have not observed stars hotter than that type, and observed spectra form the basis of the spectral sequence. However, stellar evolution models permit an estimate of the temperature of the probable main sequence counterpart of HD 93129A. If the star's temperature is currently about 43,000 K, then its main sequence temperature would have been between 57,000 and 63,000 K.

Reducing Sky Map Glare

I have a suggestion for readers who have trouble using the monthly Sky Almanac star chart because of glare from a flashlight off the glossy paper. Purchase a can of clear spray paint, like Testor's Dull Cote, and apply a thin coat directly on the star chart. The clear coating dries to a dull finish and won't glare under the flashlight's beam. One can will coat many star charts. — *K.L. Goulding, Harvard, Massachusetts*

Converting Star Chart Epochs

I have several star charts and books that list the positions of celestial objects. Although most of my books and charts list coordinates for the year 2000.0, several have 1950.0 positions listed. I like to use my setting circles to find objects, but it's confusing having coordinates for two different epochs. How do I convert the 1950.0 positions into ones for 2000.0? — *Richard Zelmer, Castroville, Texas*

— If your guide star and object both have 1950.0 coordinates listed, you do not need to convert the positions to 2000.0 coordinates. First use the 1950.0 coordinates to locate the guide star. Then use the difference between the 1950.0 coordinates for the object and guide star to find the object.

If the epochs for the two sets of coordinates are different, the short computer program in "The Coming of Epoch 2000" (August 1984 issue) will transform the coordinates for you. If you know the position for any year, the program calculates the position for any other year you desire. So you can convert your 1950.0 positions to ones for 2000.0 and vice versa. If you don't have a computer, many common reference books or books about practical astronomy contain tables or describe how to use a calculator to convert an object's position.

Calling All Astronomy Hams

Members of the southwest region of the Astronomical League, who are also amateur radio operators (hams), invite astronomers and clubs all over the world to discuss astronomy over amateur radio during the Texas Star Party. Amateur radio stations with slow-scan television equipment can also swap pictures. Call K5GH on April 28 at 9 p.m. (EDT) at 14.285 Mhz and on April 29 at 9 p.m. at 7.235 Mhz. For an astronomy-theme QSL card, send QSL and a stamped, self-addressed envelope to K5GH-TSP, 721 White Drive, Garland, TX 75040.

Last year 750 amateur radio stations from over 44 countries called our station. We will operate a radio link with the Astronomical Society of New South Wales again this year, using a new, permanent radio antenna at the Prude ranch. — *Steve Coleman, Richardson, Texas*

In Addition . . .

The caption to the stellar magnetic field maps on page 22 of the February 1992 issue should have included Ilkka Tuominen of the University of Helsinki in Finland in the list of contributing astronomers.

. . . And Correction

The credits for two photos in "Star Dust" in the March 1992 issue were switched. Michael Stecker took the photo of Ophiuchus on page 49 and Gary Emerson photographed the central region of Orion on page 48. ☐

ASTRONOMY welcomes comments and additional information on articles and astronomy in general. Send your letters to ASTRONOMY Letters, P.O. Box 1612, Waukesha, WI 53187. Letters may be edited for length or clarity.

AMATEUR ASTRONOMERS AND THE MEDIA

by Terence Dickinson

Just about everyone is thrilled to be interviewed by the media. Amateur astronomers often get their chance when a bright comet is visible, just before or after an eclipse, or around the time of Astronomy Day each year. Besides being an opportunity to bring astronomy as a hobby to a wide audience, these events give backyard astronomers a chance to bask in a bit of glory by sharing their knowledge. If your moment of fame comes, here are some guidelines about how to conduct yourself in a newspaper or television interview.

If contacted by TV or a newspaper, suggest that the TV crew or the newspaper photographer come to your home or observing site to photograph you with your equipment in your observing environment. It makes for more interesting visuals than a studio shoot.

TV interviews rarely last more than a minute. Express yourself concisely and in terms a non-astronomy audience will understand. For example: "Tomorrow there will be a total eclipse of the Moon — the Earth is passing exactly between the Moon and the Sun. This blocks sunlight falling on the Moon," or "Comets are giant chunks of snow and ice about the dimensions of a small city. When they get close to the Sun, the heat vaporizes the ice and produces a cloud of gas and a tail."

These statements are brief yet they convey a clear picture of what's going on without using jargon. Nor do they use any numbers. Although numbers are often necessary — such as the time of an eclipse or the best hour to view a comet — use them sparingly. Remember that TV viewers rarely have pencil and paper handy. Likewise with radio interviews. Keep times, dates, and other numerical information to an absolute minimum.

For television, incorporate props if you can. With your telescope or observatory as a background, use simple props like different-sized balls for the Sun, Earth, and Moon or a simplified diagram with the orbit of Earth, the Sun, and the other objects of interest for scale.

PROMOTING ASTRONOMY in the community is the task of many amateur astronomers. Here, volunteers from the Black Forest Observatory near Colorado Springs, Colorado, tape a program for a local station.

Newspaper interviews are a little different. The reporter will usually take down four or five times as much information as will be used in the final article. Your contribution may be reduced to one or two quotes if the reporter chooses to use other sources in the story. You should stick to concise, jargon-free language, but there is no need to skimp on the details of time, place, sizes, distances, and other relevant information. In printed form in the newspaper these details become a useful reference.

Keep in mind that the vast majority of your audience in these situations knows nothing about astronomy and rarely glances at the nighttime sky. Expressions like "ten degrees above the southeastern horizon" or "between Cassiopeia and Andromeda" mean nothing to 99 percent of your audience. Instead, you should say "about the width of your hand, held at arm's length, above the horizon" or "look toward the northeast about halfway from the horizon to overhead," ignoring the constellations entirely.

Although it's good to show your own enthusiasm for the subject, avoid using words like "spectacular," "brilliant," or "dazzling." Instead, simply describe the phenomenon as accurately as you can, without implying that people will see a "laser show" in the sky. Sky phenomena are often subtle, so subtle that most people never notice them. If you're suggesting that people go outside and look at something, be certain that it will be easily visible to the naked eye. If it isn't, don't talk about it. If city lights will interfere, say so. In the case of partial solar eclipses, spend most of your time talking about safe methods for viewing.

It's intoxicating to see yourself as a junior Carl or Carlene Sagan on the tube or as an expert commentator quoted in the newspaper. You may want to contact the media every time a dramatic celestial event is due, or even marginal events, such as a shallow partial eclipse of the Sun or Moon, or a poor meteor shower. Don't let your enthusiasm for astronomy cloud your judgement. Newspaper, radio, and TV reporters deal every day with people who want to get their name in the paper or their face on the screen. If they sense you are one of these people, you will likely be cut off for good.

If bringing astronomy to the public turns you on, consider establishing a newspaper column in your community. Caution: big-city daily newspapers are tough to break into. So don't be surprised if your offer receives no reply. Your proposal will be just one of hundreds offering one editorial service or another each year. You are more likely to get a warm reception from your community weekly newspaper. These papers are always looking for free material to place between the ads and will probably welcome your contribution. (Don't expect any payment, though.) Columns that run once a month will probably be enough to keep you busy.

Other outlets are local cable television companies. Many of them reserve a channel for community broadcasts and usually have a tough time filling the blocks of time available. For over a decade, Randy Attwood of the Toronto Centre of the Royal Astronomical Society of Canada produced "Astronomy Toronto," one of the most successful amateur astronomy programs on cable television. In the *Journal of the Royal Astronomical Society of Canada* Attwood explained that "The major reason for the inception of 'Astronomy Toronto' was the absence of astronomy on regular television. I was frustrated with the 60-second overview reports television stations were giving to astronomical topics, such as space probe discoveries."

In the fall of 1980, Attwood wrote to the five cable television operators in the Toronto area, offering to produce a series of astronomy programs. One company with 300,000 subscribers gave a positive response and offered a three-show trial. These pilot episodes were so

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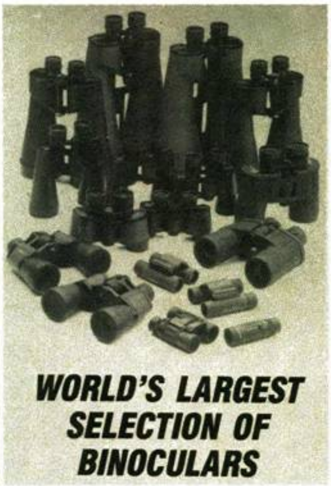

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Thousand Oaks Optical solar filters are recognized around the world for their quality, consistent density and even coating across the entire aperture. We specialize in solar filters only and are the largest solar filter manufacturer in the world. Filters are available to fit all brands of telescopes and binoculars. **Thousands of our filters are in use around the world. The preferred choice of telescope dealers and exclusively used by NASA aboard the Space Shuttle.**

TYPE 1 - Made from high quality hand select glass, machine polished and **TRIPLE COATED** with a Nickel-Chromium alloy (same as Inconel). Mounted in a machined aluminum cell ready to attach to telescope. Solar image is yellow-orange. No secondary filtering is necessary.

TYPE 2 - Same as type 1, except stainless steel is combined in the coating to provide an even more durable surface that highly resists wear due to excessive handling and ultraviolet radiation. Solar image is also yellow-orange.

TYPE 3 - Coated to a neutral density of 4 for serious astrophotographers who desire the shortest possible shutter speeds with slow films. Solar image and optical quality same as type 1 and 2. Type 3 filters are for photographic use only.

Type 1 & 2 are for unlimited visual use and general photographic use. Instructions included with all filters, including tips on solar photography.

Our filters are many times more durable than common aluminized Mylar. Aluminized plastic cannot hold up to long term ultraviolet radiation and environmental contaminants as well as Nickel-chrome and stainless steel coated glass. Wrinkled Mylar can cause visual and photographic difficulties, can be easily damaged in handling or if placed on an uneven surface, and is difficult to clean. Also, a light blue solar image does not yield as much detail and contrast.

GLASS (Full Aperture) Type 1

Aperture	mounted:	Aperture	unmounted:
2.4"	$ 49.00	2.4"	$ 39.00
3.1"	52.00	3.1"	42.00
3.5" to 4"	59.00	3.5" to 4"	49.00
4¼" to 5"	74.00	4¼" to 5"	64.00
6"	79.00	6"	69.00
8"	95.00	8"	85.00
10"	109.00	10"	99.00
11"	119.00	11"	109.00
12.5" to 13.1"	149.00	12.5" to 13.1"	129.00
14"	169.00	14"	149.00
40mm to 80mm Binoculars - Mounted			$ 92.00 pr.

GLASS (Full Aperture) Type 2

Aperture	mounted:	Aperture	unmounted:
2.4"	$ 62.00	2.4"	$ 52.00
3.1"	65.00	3.1"	55.00
3.5" to 4"	76.00	3.5" to 4"	66.00
4¼" to 5"	96.00	4¼" to 5"	86.00
6"	105.00	6"	95.00
8"	125.00	8"	109.00
10"	139.00	10"	119.00
11"	149.00	11"	139.00
12.5" to 13.1"	179.00	12.5" to 13.1"	159.00
14"	199.00	14"	179.00
40mm to 80mm Binoculars - Mounted			$115.00 pr.

GLASS (Full Aperture) Type 3

Aperture	mounted:	Aperture	unmounted:
2.4"	$ 79.00	2.4"	$ 65.00
3.1"	82.00	3.1"	69.00
3.5" to 4"	99.00	3.5" to 4"	79.00
4¼" to 5"	125.00	4¼" to 5"	110.00
6"	135.00	6"	115.00
8"	159.00	8"	139.00
10"	172.00	10"	152.00
11"	199.00	11"	179.00
12.5" to 13.1"	229.00	12.5" to 13.1"	209.00
14"	259.00	14"	239.00

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ORDERING INFORMATION: Solar filters are shipped free in continental U.S. when payment is included with order. Shipping extra on credit card orders ($3 - $6 depending on aperture). Payment may be made by personal check, bank check or money order. We also accept **Visa, Mastercard** and **American Express. PLEASE SPECIFY TELESCOPE BRAND AND/OR OUTSIDE DIAMETER MEASUREMENT OF TELESCOPE TUBE.** The cost of the filter is based on the telescope aperture. The mounting cell fits over and around the end of the telescope tube (friction fit). The coating faces the inside. Unmounted filters are the glass only.

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successful that Attwood and his colleagues from the RASC got a permanent slot and produced more than 50 shows over the next ten years. Programs ranged from live phone-ins to real-time hookups to the NASA feed for the Voyager encounters. They also taped tours of professional and amateur observatories in the area.

Audience response to the shows was excellent. The phone-in shows, for example, received more calls than speakers had time to answer. But the biggest satisfaction for Attwood and his production team came from the freedom to talk about any astronomy topic they wanted without the time constraints imposed by commercial television. Attwood offers these hints for anyone interested in this activity:

"To prepare for each show, I first chose a topic of general interest to the audience, and then a guest. I suggested that the 30-minute show be broken up into five or six short segments. We gave each segment a time allotment and then chose the slides for each segment. I always found it important to schedule slides or visuals to appear for half the time in each show."

Producing a half-hour cable TV show requires a lot of preparation. It's far more time-consuming than it would seem. But Attwood says it is well worth it. "One day, as I was watching television and flicking channels with the remote changer, I stopped at an image of Saturn. I immediately thought I was watching a Nova rerun. A few seconds later, the host appeared — me. This is how many people discovered our show."

Over the decade "Astronomy Toronto" was on the air, Attwood feels he brought astronomy to many people who would otherwise have had little contact with the subject. Other avid amateur astronomers agree with this mission — thousands volunteer their evenings and weekends to promoting astronomy, perhaps through cable TV shows, newspaper columns, media interviews, or, as will be the case on May 9 this year at many locations, through local Astronomy Day programs.

If you are one of the great unpaid promoters of astronomy, the hobby owes you a great "thank you." If you have not yet had your moment before a microphone or TV camera, perhaps your opportunity will come. But if your chance to publicize astronomy extends no farther than showing your neighbor the Moon through your telescope, you will still have done a wonderful thing. ☐

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For more information, a free color catalog, and the name of your nearest dealer, please contact us. If there is no dealer near you, order directly. Major credit cards and certified checks accepted.

10 x 70 FMT-SX
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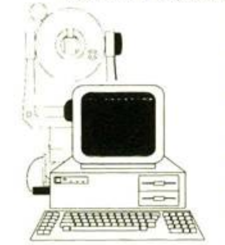

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Motor is equipped with variable speed control. These motors are designed for use with manufacturer's hand unit, or drive corrector - if you have neither, the motor may be ordered with a hand control (add $10). GEM and Polaris/Super Polaris owners add $20.

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9. WHEELEY BARS™

Move those large 'scopes around with ease! With locking casters, designed for hard surfaces. Specify Meade field tripod, C-11/C-14, or Ultima 8/11.

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- The accessories we offer for your telescope are listed to the right.

(We offer accessories for the telescopes listed below, not the 'scopes themselves.)

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2080/2120/LX2	1,2,3,4,5,6,7,9
LX3	1,2,3,4,5,6,9
LX5	1,2,3,4,5,6,9
LX6	1,2,3,4,5,6,9
Premier	1,2,3,4,5,6,9
DS10	1,2,3,4,5,7
DS16	1,2,3,4,5,7
2040	1,2,3,4,7
2045	1,2,3,4,6,7
2045D	1,2,3,4,6
440/2080/2120 GEM	1,2,3,4,6,8
295/320/6600/8800	5,6,8
310/622/LX100/LX200	5
628/645/826/856	1,2,3,4,5,7
880/1060/1266	1,2,3,4,5,7
2080/2120 MTS	1,2,3,4,5,6
6600/8800 MTS	1,2,3,4,6
CELESTRON	
C-8/Super C-8	1,2,3,4,5,6,7
C-11	1,2,3,4,5,6,7,9
C-14	1,2,3,4,5,9
Ultima 8*	1,2,3,4
Ultima 11*	1,2,3,4
Super Polaris C-8	1,2,3,4,5,6
SPC-90/SPC-102	1,2,3,4,5,6
Polaris C60/C70/C80/C100	5,6
Polaris C-6/C-125	6
Polaris C-4.5	5,6
C-5	1,2,3,4,5,7
Powerstar* (all)	1,2,3,4
Astrophysics	
2" Focuser	5
2.7" Focuser	5
DX Mount	1,2,3,4,6
600 Mount	1,2,3,4
800 Mount	1,2,3,4
Bausch & Lomb/Dynamax	
B&L 4000	1,2,3,4,5,6,7
B&L 8000/Dynamax 8	1,2,3,4,6,7
Coulter	
Odyssey 8/10/13/17 (specify)	1,2,3,4
Obsession	
Obsession 20/25 (specify)	1,2,3,4
Questar	
Questar 3.5	1,2,3,4
Takahashi	
EM-1	1,2,3,4,6
EM-10/EM-200/NJP/P-160 (specify)	1,2,3,4
All but TSC	5
TeleVue	
Genesis/Oracle/Renaissance	5
Systems Mount	1,2,3,4,6
Mount of Gibralter	1,2,3,4
Vixen	
Refractors/SC	5
Vixen Super Polaris	1,2,3,4,6

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S92EP

STAR PARTIES

With the spring comes a new season of amateur astronomy meetings. Some gatherings take the form of outdoor star parties while some are indoor conferences. But all are great places to meet people that share your love of the stars. This list includes major regional events from late April to early November for the United States and Canada and was compiled from ASTRONOMY's 1992 Club Survey. Please see the Meetings and Events department on page 108 of this issue and in subsequent issues for listings of more astronomy events in 1992.

APRIL

April 24 – 25 / Wisconsin

46th Annual Astronomical League North Central Regional Convention, Pewaukee. Sponsored by the Milwaukee Astronomical Society. Contact: Dan Koehler, W248 S7040 Sugar Maple Drive, Waukesha, WI 53186, (414) 662-2987.

April 27 – May 2 / Texas

Texas Star Party, Prude Ranch, near Fort Davis. Hosted by the Southwest Region of the Astronomical League. Contact: TSP Registrar Bobby Braley, P.O. Box 386, Wylie, TX 75098.

MAY

May 1 – 2 / New York

Astronomy Festival, Kopernik Observatory, Underwood Road, Vestal Center. Contact: Roberson Museum and Science Center, 30 Front Street, Binghamton, NY 13905, (607) 772-0660.

May 1 – 9 / Tennessee

4th Annual Middle Tennessee Astronomy Celebration. Contact: Sudekum Planetarium of the Cumberland Science Museum, 800 Ridley Boulevard, Nashville, TN 37203, (615) 862-5160, ext. 83 or 13.

May 9 /

Astronomy Day. Activities staged by astronomy clubs and planetariums in many cities. Contact: Gary Tomlinson, Astronomy Day Coordinator, Public Museum of Grand Rapids, MI 49503, (616) 456-3987.

May 9 / New Jersey

Astronomy Day Celebration, Sperry Observatory, Union County College, Cranford. Largest astronomy event of the year in New Jersey. Contact: Amateur Astronomers, Inc., 1033 Springfield Avenue, Cranford, NJ 07016.

May 15 – 16 / Oklahoma

Northwest Oklahoma Star Party, Enid. Contact: Northwest Oklahoma Astronomy Club, 1719 Pawnee, Enid, OK 73703, Dan Matthews, (405) 233-5707.

May 22 – 24 / California

Riverside Telescope Makers Conference, Camp Oakes, Big Bear Lake area. Contact: RTMC, Fox and Stephens, CPA, 9045 Haven Avenue #109, Rancho Cucamonga, CA 91730, (714) 948-2205.

May 22 – 24 / North Carolina

Southern Star Astronomical Convention. Sponsored by the Charlotte Amateur Astronomers Club. Contact: Harold Melvin, 418 School Circle, Harrisburg, NC 28075.

May 29 – 31 / New Jersey

Jersey Star Quest III, United Methodist Camp, Browns Mills. Contact: Amateur Astronomers Association of Princeton, P.O. Box 2017, Princeton, NJ 08540, Greg Mauro, (609) 586-5732 (evenings) or (609) 490-3560 (days).

May 29 – 31 / Pennsylvania

Renaissance '92, Mercyhurst College, North East near Erie, Pennsylvania. Contact: Tom Bemus, RD #3, Box 161A, Bemus Point, NY 14712, (716) 386-4566.

May 30 – June 7 / Arizona

2nd Annual Grand Canyon Star Party, Grand Canyon National Park. Sponsored by the Tucson Amateur Astronomy Assoc. Contact: TAAA, 1122 East Greenlee Place, Tucson, AZ 85719.

JUNE

June 5 – 7 / Arkansas

Arkansas Star Party, Coleman Observatory, Hackett (25 miles south of Fort Smith). Contact: Arkansas-Oklahoma Astronomical Society, P.O. Box 31, Fort Smith, AR 72903, Joe Roam, (501) 474-4740.

June 12 – 13 / Ohio

22nd Annual Apollo Rendezvous and Telescope Fair, Dayton Museum of Natural History. Contact: Miami Valley Astronomical Society, 5932 Culzean Drive #706, Dayton, OH 45426, Ian Dumbauld, (513) 837-4600.

June 19 – 21 / Missouri

Astronomical League Mid-States Regional Convention, Avila College and Powell Observatory, Kansas City. Sponsored by the Astronomical Society of Kansas City. Contact: Jackie Wade, 11305 King Street, Overland Park, KS 66210, (913) 469-0135.

June 20 / Oklahoma

Prairie Star Party, Bartlesville. Contact: Bartlesville Astronomical Society, Route 2, Box 940, Bartlesville, OK 74006, Ken Willcox, (918) 333-1966 (evenings) or (918) 336-9900 (days).

June 20 – 25 / Wisconsin

Universe '92, a National Astronomy Expo, University of Wisconsin, Madison. Presented by the Astronomical Society of the Pacific and ASTRONOMY magazine. Amateur astronomy product fair and talks June 20 – 21. Contact: Wisconsin Meeting Information, A.S.P., 390 Ashton Avenue, San Francisco, CA 94112, (415) 337-1100.

June 26 – 28 / Pennsylvania

Mason-Dixon Star Party, Spring Valley County Park, Glen Rock. Contact: York County Parks Astronomical Society, 400 Mundis Race Road, York, PA 17402, Jeri Jones, (717) 771-9440.

June 26 – 28 / Wisconsin

Wisconsin Observers' Weekend, Hartman Creek State Park, Waupaca. Contact: NEWSTAR, the Northeast Wisconsin Stargazers, 1815 Kienast Avenue, Oshkosh, WI 54901, Don Wyman, (414) 233-3083 (evenings).

June 27 / Ohio

Ohio Association of Amateur Astronomers Conference, Hiram College, Cleveland. Contact: Cuyahoga Astronomical Association, P.O. Box 29089, Cleveland, OH 44129-0089, Bill Gerling, (216) 779-9779 (evenings).

JULY

July 1 – 5 / Alberta

General Assembly of the Royal Astronomical Society of Canada, Calgary. Contact: Calgary Centre – R.A.S.C., c/o Dennis Goodman, 28 Southland Crescent SW, Calgary, Alberta, Canada T2W 0K3, (403) 252-7095.

July 3 – 5 / Colorado

Annual Star Stare Campout and Star Party, Badger Flats. Contact: Colorado Springs Astronomical Society, P.O. Box 62022, Colorado Springs, CO 80962, Jim Lawrence, (719) 593-0801.

July 13 – 18 / California

COSMOCON '92 National Convention, San Jose State University. Sponsored by Astronomical Association of Northern California, the Association of Lunar and Planetary Observers, the Astronomical League, and the Western Amateur Astronomers. Contact: Don Stone, 4917 Mountain Boulevard, Oakland, CA 94619, (510) 376-3007.

July 24 – 26 / New York

Syracuse Summer Seminar, Darling Hill Observatory, Vesper. Contact: Syracuse Astronomical Society, Inc., 601 Bear Street, Syracuse, NY 13208-1101, Sue Rugelis.

July 26 – 28 / Wisconsin

Northwoods Starfest, Hobbs Observatory Center, Beaver Creek Reserve. Sponsored by the Chippewa Falls Astronomical Society. Contact: Bob Elliott, Hobbs Observatory, Route 2, Box 94, Fall Creek, WI 54742, (715) 877-2787.

July 30 – August 3 / Alberta

Alberta Star Party, Kinbrook Island Provincial Park. Contact: Calgary Centre – R.A.S.C., P.O. Box 2100, Station M, Calgary, Alberta, Canada T2P 2M5, Ruth Lewis, (403) 283-0570.

July 31 / Utah

Mountain States Star Party, Monte Cristo Campground, Cache/Wasatch National Forest. Contact: Ogden Astronomical Society, 2336 West 5650 South Street, Roy, UT 84067, Bob Tillotson, (801) 773-8106.

July 31 – August 1 / Indiana

Summer Spectacular Star Party, Lemon Lake County Park, Crown Point. Contact: Calumet Astronomical Society, P.O. Box 851, Griffith, IN 46319, (219) 845-9174.

July 31 – August 2 / Colorado

Mountain Astronomers Rendezvous and Star Party. Contact: Denver Astronomical Society, P.O. Box 10814, Denver, CO 80210, Dave Trott, (303) 871-5172.

July 31 – August 2 / Nova Scotia

Highland Star Party, Cape Breton Highlands National Park. Contact: Cape Breton Astronomical Society, 131 Green Acres Drive, Sydney River, Nova Scotia, Canada B1S 1K5, John Reppa, (902) 562-2772.

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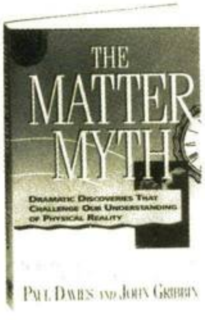
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Paul Davies and John Gribbin

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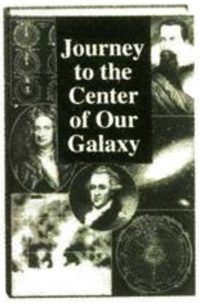
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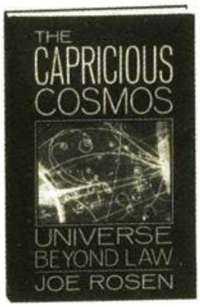
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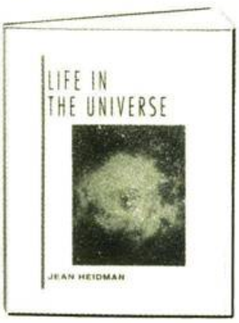
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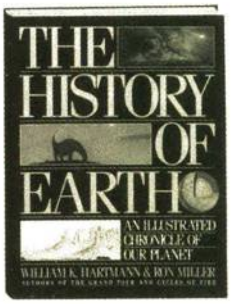
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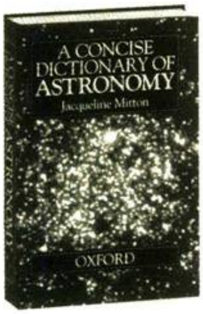
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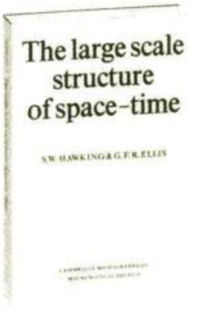
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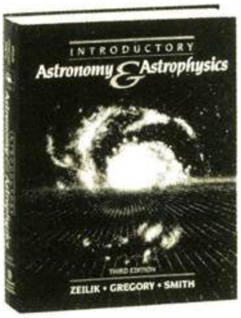
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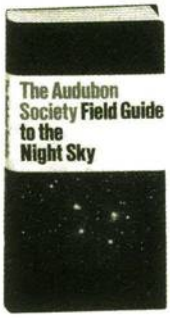
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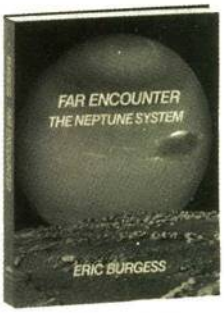
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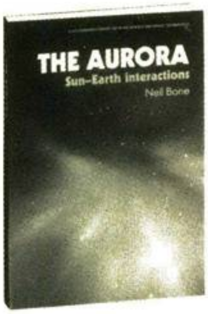
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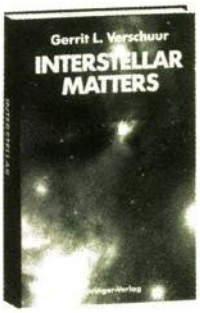
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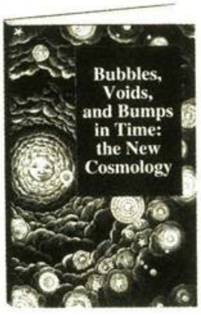
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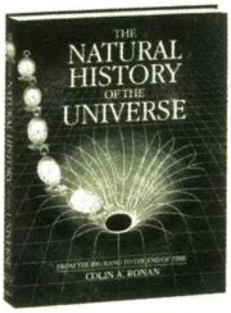
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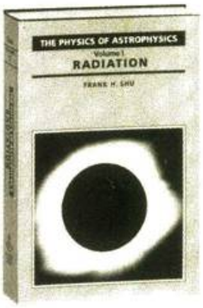
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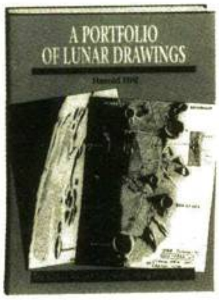
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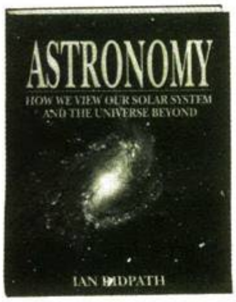
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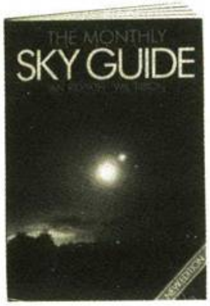
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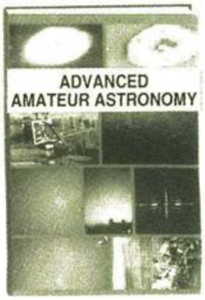
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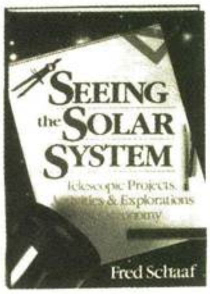
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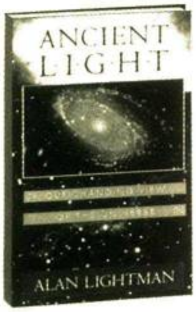
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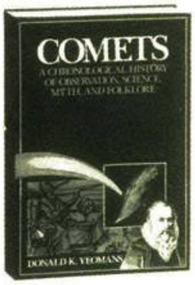
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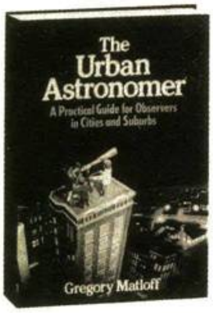
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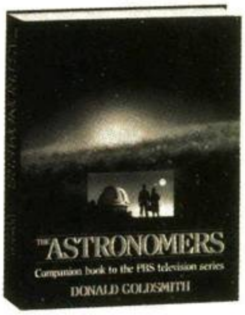
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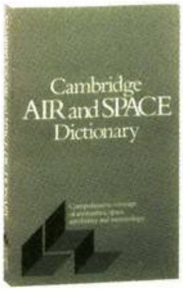
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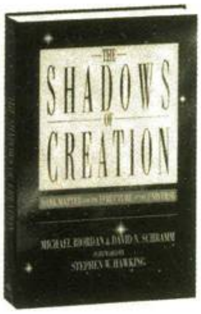
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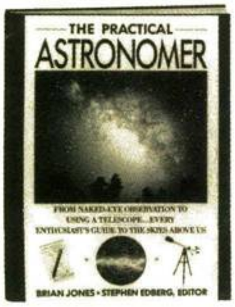
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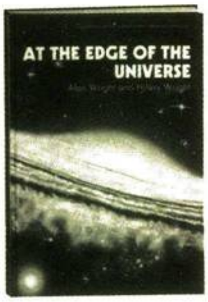
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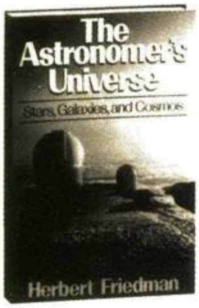
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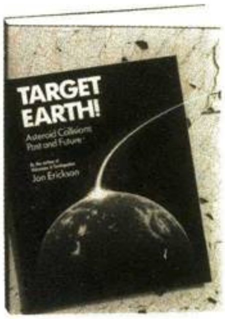
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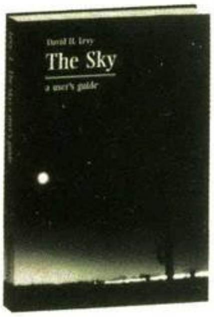
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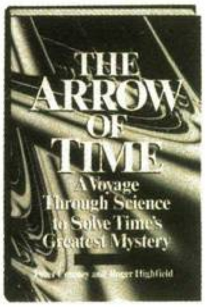
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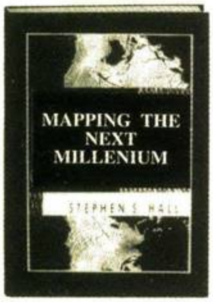
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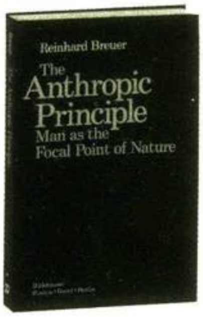
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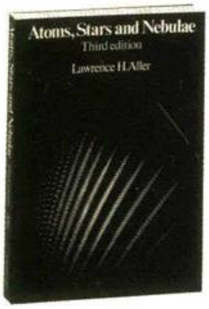
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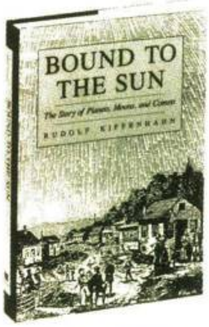
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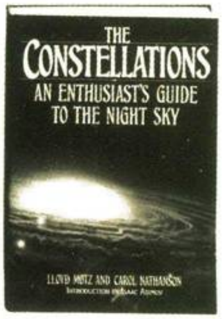
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Astronomical League Northwest Regional Convention and High-Altitude Star Party, Table Mountain, near Ellensburg. Contact: Thom Jenkins, P.O. Box 8114, Spokane, WA 99203-0114, (509) 838-1381.

AUGUST

August 7 – 9 / Michigan
Southern Michigan Universal Regional Festival of Stargazers (SMURFS), near Clare. Contact: Genesee Astronomical Society, c/o Robert T. Longway Planetarium, E. Kearsley Street, Flint, MI 48503, Richard Walker, (313) 627-9524.

August 8 / Nebraska
Prairie Astronomy Club Star Party, Hyde Observatory, Holmes Park, Lincoln. Contact: Prairie Astronomy Club, P.O. Box 80553, Lincoln, NE 68501, Lee Thomas, (402) 483-5639. Rain/cloud date: August 22.

August 15 / California
Annual Star Party, Winchester Canyon Gun Club, Santa Barbara. Contact: Santa Barbara Astronomy Club, P.O. Box 3702, Santa Barbara, CA 93130, Clyde Kirkpatrick, (805) 966-3695.

August 22 / Ohio
Ohio Turnpike Astronomers Association Convention, Indian Hill Observatory, Chagrin Falls. Contact: Chagrin Valley Astronomical Society, P.O. Box 11, Chagrin Falls, OH 44022, Bob Modic, (216) 636-5789.

August 22 / Virginia
Tidewater Summer Star Party, Portsmouth Campus, Tidewater Community College. Contact: Tidewater Community College Astronomical Society, Physics Dept., State Route 135, Portsmouth, VA 23703, Aubrey Hartman, (804) 484-2121 ext. 235.

August 27 – 30 / Oregon
5th Annual Oregon Star Party, Ochoco Mountains, 60 miles NE of Bend. Sponsored by Rose City Astronomers of Portland. Contact: Check Dethloff, 1511 NW Oakmont Loop, Beaverton, OR 97006, (503) 629-2145.

August 27 – 31 / British Columbia
Mount Kobau Star Party, summit of Mount Kobau near Osoyoos. Contact: Peter Kuzel, 4100 25th Avenue, Vernon, BC, Canada V1T 1P4, (604) 545-1226.

August 28 / Utah
Mountain States Star Party, Monte Cristo Campground, Cache/Wasatch National Forest. Contact: Ogden Astronomical Society, 2336 West 5650 South Street, Roy, UT 84067, Bob Tillotson, (801) 773-8106.

August 28 – 29 / Massachusetts
The Conjunction, Northfield Mountain Environmental Center, Northfield. Contact: Jack Megas, 311 Surrey Road, Springfield, MA 01118.

August 28 – 29 / Ontario
Starfest '92 (11th annual), Riverplace

Campground, Mount Forest, Ontario. Sponsored by the North York Astronomical Association. Contact: Andreas Gada, 26 Chryessa Avenue, Toronto, Ontario, Canada M6N 4T5.

August 28 – 30 / Idaho
Southern Idaho Regional Star Party, Bruneau Sand Dunes State Park, near Mountain Home. Contact: Boise Astronomical Society Inc., P.O. Box 8386, Boise, ID 83707.

August 29 – 31 / New Brunswick
Nova East '92, Fundy National Park. Contact: Halifax Centre of the R.A.S.C., 1747 Summer Street, Halifax, Nova Scotia, Canada B3H 3A6, Mary Lou Whitehorne, (902) 865-0235.

SEPTEMBER

September 18 – 19 / Kentucky
Twin Lakes Star Party, Golden Pond Observatory. Contact: West Kentucky Amateur Astronomy Club, Land Between the Lakes, Golden Pond, KY 42211, Jim Boren, (615) 232-6820 (evenings) or (615) 232-7405 (days).

September 18 – 20 / Illinois
Astrofest '92, Shaw-Waw-Nas-See 4H Camp, near Kankakee. Hosted by the Chicago Astronomical Society. Contact: Astrofest, P.O. Box 596, Tinley Park, IL 60477, Alan Birkner, (708) 966-6214.

September 25 – 26 (tentative) / Indiana
Northern Indiana Astronomical Groups NIAG Fest '92, Camp Crossley, Warsaw. Contact: Michiana Astronomical Society, P.O. Box 262, South Bend, IN 46624-0262, John Greenlee, (219) 255-8501.

September 25 – 26 / Nevada
6th Annual Dark Sky Observing Party, Cathedral Gorge State Park, Panaca. Hosted by the Las Vegas Astronomical Society. Contact: Jim Mellor, G.W. Hotels, 401 South Casino Center, Las Vegas, NV 89101, (800) 634-6635.

September 25 – 26 / Ohio
Hidden Hollow '92, Mansfield. Contact: Richland Astronomical Society, P.O. Box 1118, Mansfield, OH 44901-9998, Keith Moore, (419) 468-3542 (evenings) or (419) 755-7796 (days).

September 25 – 26 / Virginia
Northern Virginia Telescope Meet, C.M. Crockett Park, Calverton. Send a long SASE to: Bob L'Hommedieu, 4415 Eastwood Court, Fairfax, VA 22032, (703) 978-0946.

September 25 – 27 / Connecticut
2nd Annual Connecticut Star Party, Colebrook. Contact: Astronomical Society of New Haven, P.O. Box 3005, New Haven, CT 06515, Linda Marks, (203) 874-4816.

September 25 – 27 (tentative) / Iowa
Eastern Iowa Star Party, location to be announced. Contact: Quad Cities Astronomical Society, P.O. Box 3708, Davenport, IA 52808, Wayne Jens, (319) 326-4995.

September 25 – 27 / Wyoming
Weekend Under the Stars, Fox Park, Wyoming. Sponsored by the Cheyenne Astronomical Society. Contact: Marty Curran, 6614 North College #G, Cheyenne, WY 82009, (307) 635-5944.

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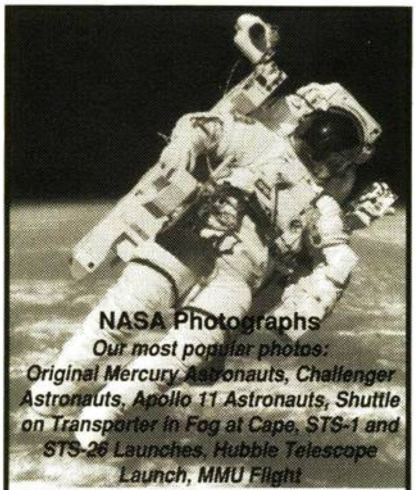

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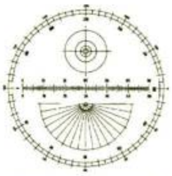

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Star Parties

September 26 / North Carolina

Blue Ridge Parkway Regional Stargaze (Part 1), Julian Price Park, 4.5 miles south of Blowing Rock. Sponsored by the Catawba Valley Astronomy Club. Contact: Greg Kirby, Route 3, Box 472, Granite Falls, NC 28630, (704) 396-7656.

September date TBA / Quebec

Congrès Annuel de l'Association des Groupes d'Astronomes Amateurs, Longueuil. Contact: Jean-Marc Richard, 4545 Au-Pierre-de-Coubertin, C.P. 1000, Succasale M, Montréal, PQ, Canada H7V 3R2, (514) 252-3038.

OCTOBER

October 2 – 4 / Pennsylvania

Stella-Della-Valley V, Camp Onas, Ottsville. Contact: Bucks-Mont Astronomical Association, 1443 Devon Road, Warminster, PA 18974, Edward Melnick, (215) 443-7929.

October 17 / Indiana

Saturn Watch '92, Butler University's Holcomb Observatory, Indianapolis. Contact: Indiana Astronomical Society, 2 Wilson Drive, Mooresville, IN 46158, J. Philip May, (317) 831-8387 (evenings) or (317) 831-3009 (days).

October 17 / Tennessee

Starfest '92, Bays Mountain Park. Contact: Bays Mountain Amateur Astronomers, 853 Bays Mountain Park Road, Kingsport, TN 37660, Charles Ferguson, (615) 229-9447.

October 19 – 25 / Texas

Okie-Tex Star Party, Prude Ranch, near Fort Davis. Contact: Oklahoma City Astronomy Club, P.O. Box 21221, Oklahoma City, OK 73156, Clive or Beryl Cadle, (405) 789-3742.

October 22 – 25 (tentative) / Georgia

Georgia Star Party, Hard Labor Creek Observatory (60 miles east of Atlanta). Contact: Astronomical Society of the Atlantic, Inc., c/o Center for High Angular Resolution Astronomy, Georgia State University, Atlanta, GA 30303-3083, Don Barry, (404) 651-2932 (days).

October 22 – 25 / Mississippi

Deep South Regional Stargaze, Percy Quinn State Park. Contact: Ponchartrain Astronomy Society, 820 Emerald Street, New Orleans, LA 70124, Barry Simon, (504) 283-7592.

October 23 – 25 / New York

14th Annual Astronomy Jamboree, Custer Institute, Southold. Contact: Custer Institute Observatory, Box 1204, Main Bayview Rd., Southold, NY 11971, Charles Cardona, (516) 298-4227 or Barbara Lebkuecher, (516) 722-3850.

October 24 / North Carolina

Blue Ridge Parkway Regional Stargaze (Part 2), Julian Price Park, 4.5 miles south of Blowing Rock. Sponsored by the Catawba Valley Astronomy Club. Contact: Greg Kirby, Route 3, Box 472, Granite Falls, NC 28630, (704) 396-7656.

NOVEMBER

November 6 – 7 / Indiana

Fall Spectacular Star Party, Lemon Lake County Park, Crown Point. Contact: Calumet Astronomical Society, P.O. Box 851, Griffith, IN 46319, (219) 845-9174. □

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NEW PLANETS, BLACK HOLES, AND COSMOLOGY

More than 1,500 professional astronomers gathered in Atlanta, Georgia, from January 12-16, 1992, for the 179th meeting of the American Astronomical Society (AAS). Among the wide range of topics they discussed were the existence of planets outside of our solar system, the validity of the Big Bang, the probability that black holes lying deep inside the nuclei of galaxies, and the nature of powerful and mystifying gamma-ray bursts in the universe. What follows is a brief description of some of the most newsworthy stories from the meeting.

Pulsar Planets Real and Unreal. Ironically, perhaps the most stunning news was the announcement of an object that did *not* exist. Last autumn Andrew Lyne and his colleagues at the University of Manchester startled the astronomical community when they announced the existence of a planet orbiting the pulsar PSR 1829–10 (see "The First Planet Beyond the Solar System," December 1991 issue). Lyne and colleagues based their conclusion on the changing "tick" of the pulsar's clock, which seemed to signify a period in the pulses of 184.4 days. The astronomers concluded that a planet with 10 times the mass of Earth must be orbiting the pulsar, causing the variations in what would otherwise be a precisely regular clock.

When he updated fellow astronomers on the second six-month batch of observations from 1991, however, Lyne took everyone at the Atlanta meeting by surprise. He announced that the fluctuations in the pulses were due to uncorrected errors in the Earth-based observations, and therefore there is no planet orbiting pulsar PSR 1829–10. The problem arose from wrongly accounting for the location of the observing platform — Earth — during the observations. Computational mistakes had stopped one of astronomy's most exciting stories in its tracks. Lyne told a group of journalists gathered at an impromptu press conference, "When you think you've thought of everything, there's still something lurking in the procedures that you're just not aware of. We're human, and occasionally we make such mistakes."

However, that was simply one side of the pulsar-planet coin. Another group of astronomers announced they had discovered a different pulsar with at least two planetary companions, and this one appears to be passing all of the skeptics' tests. "The degree of confidence of the existence of the planets is very high," says Aleksander Wolszczan, the astronomer who conducted the research at the Arecibo Observatory in Puerto Rico. Wolszczan conducted the research with Dale Frail of the National Radio Astronomy Observatory. The object is a millisecond pulsar designated PSR 1257+12, and the radio observations made by Wolszczan and Frail suggest that at least two planets and possibly three are in orbit about the star.

The pulsar emits 160 pulses of radio energy each second, and this allows astronomers to use it as an ultra-precise clock. The star is the remnant from a supernova explosion that occurred hundreds of millions of years ago. It measures only about 20 kilometers across but weighs in at 1.4 solar masses. The planetary companions have nearly circular orbits at distances of 0.36 and 0.47 astronomical units (AU). The respective masses are thought to be 3.4 and 2.8 times that of Earth. Detailed studies suggest the existence of a third planet, about 1.1 AU from the star.

How could planets exist around a star that once exploded? The astronomers hypothesize that the pulsar originally had a companion star, and the two existed for some 10 million years as a normal binary star. When the more massive star exploded as a supernova, material from this event accreted into the planets. Unlike the planets in our solar system, the planets orbiting PSR 1257+12 are "second generation" objects in that they were not present in the original PSR 1257+12 system.

Because PSR 1257+12 is a millisecond pulsar, the precision of the data gathered by Wolszczan and Frail is very high. "It is far more difficult to mimic planetary bodies with two or more planets involved," says Frederic A. Rasio of Cornell University. Rasio and colleagues executed a series of computer simulations of the evolution of the system, and found that the observations matched their hypotheses very well. Stan E. Woosley of the University of California at Santa Cruz, an expert on supernovae, predicts, "As we watch this subject over the next five years, we'll have many more such objects. This one's for real."

New Findings from the Hubble Space Telescope. Astronomers in Atlanta announced results from a series of Hubble Space Telescope (HST)

THE INTERIOR OF GIANT GALAXY M87 is visible in this Hubble Space Telescope image made with the Wide Field/Planetary Camera. The nucleus is visible at left center; a 2.6 billion solar mass black hole probably lies within it. The galaxy's prominent plasma jet flows from the nucleus to the right side of the image. The scattered points of light in the field are globular clusters orbiting the galaxy's center. NASA image.

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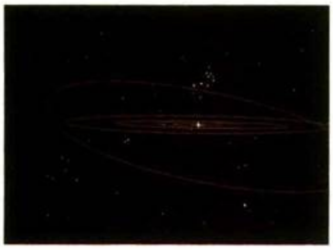
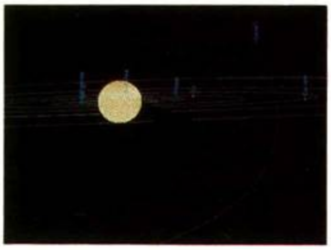
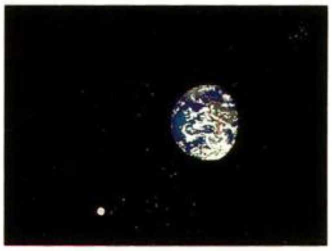


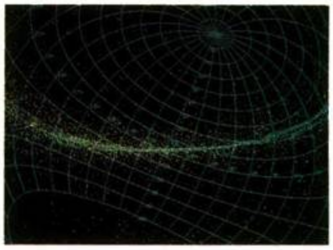
The solar system from 36 light-hours distance.



Jupiter expelling comet Lexell from solar system in 1779.

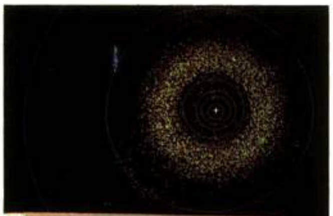


Earth and Moon in Taurus, 16 Oct 2000.

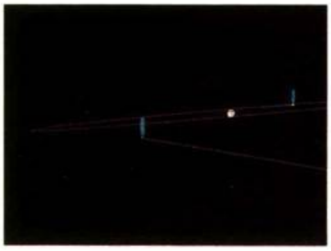


Celestial Skymap with asteroids along the ecliptic.

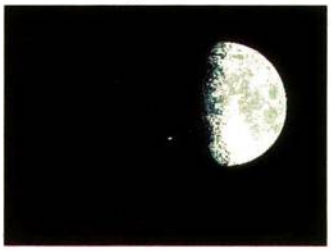
Polar view of asteroid belt – Jupiter and the Trojan asteroids.



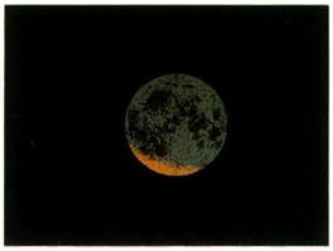
Asteroid 1991BA passing close to Earth. 18 Jan., 17.5h, 1991.

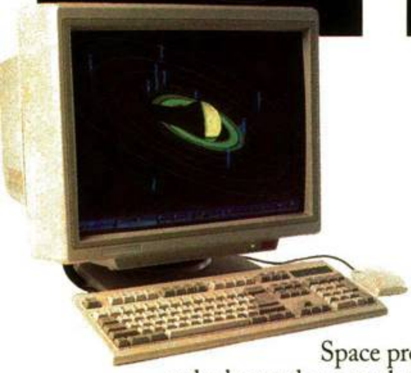


Saturn slipping behind the moon. From Osaka Japan, 8 Oct. 1962.



Lunar eclipse of 9 Feb. 1990, near maximum.





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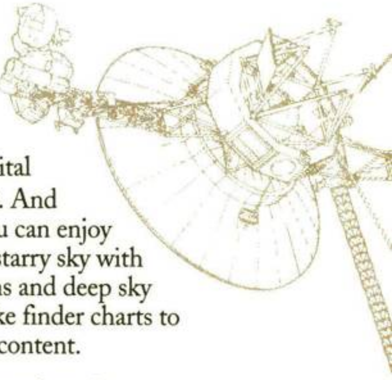

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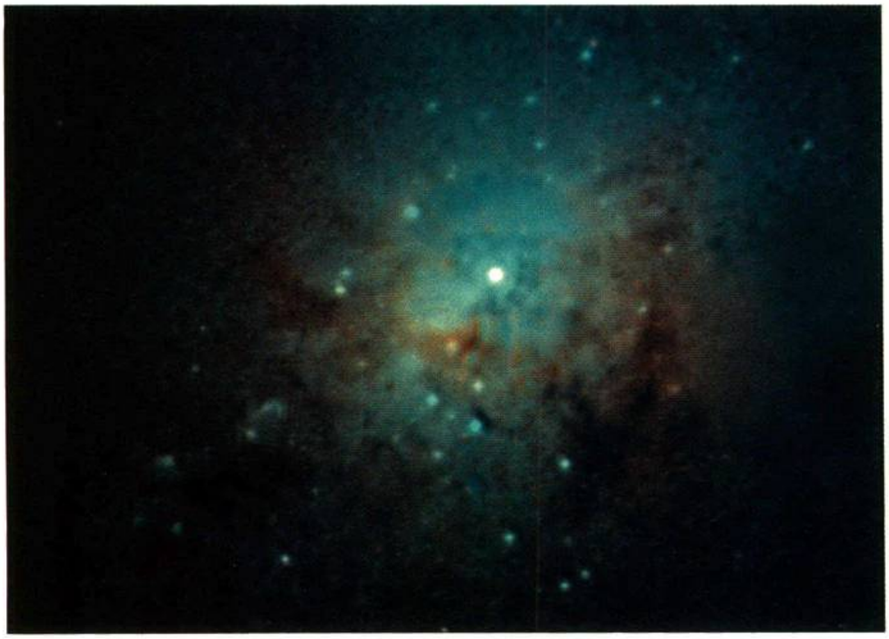

A PEEK INSIDE the radio galaxy Perseus A (NGC 1275) with the Hubble Space Telescope revealed a previously unknown population of young, bluish globular clusters (scattered across the frame, surrounding the nucleus). These young clusters may have formed following the galaxy's collision with another galaxy around 1 billion years ago. NASA image.

observations. "We're reeling from extraordinary things," says John Bahcall of the Institute for Advanced Study in Princeton, New Jersey. Cosmology was foremost among them. "HST imaging of gravitational lensing of quasars will set new constraints that cosmological models must satisfy, and will rule out other models," says Bahcall. The so-called Snapshot Survey uses HST to look at the possible gravitational lensing of distant quasars. By studying lensed images closely, astronomers can infer something about the intervening material between the quasar and Earth, because this material acts as a lens to amplify light from distant objects. Such observations may reveal much about what the universe is composed of and where the missing mass of the universe could be found.

Observations made with HST strongly support the Big Bang theory. Jeffrey Linsky of the National Institute of Standards and Technology used HST to measure the ratio of deuterium to hydrogen produced in the early universe. Linsky's observations, by far the most precise ever made, support the idea that the universe is open, which is to say it will expand forever rather than fall back on itself and regenerate. "If the universe is closed," says Linsky, "then a *huge* amount of unknown material must be out there somewhere, and this material can't be ordinary matter."

The observations centered on the star Capella, which Linsky and colleagues observed with HST's Goddard High Resolution Spectrograph. They found the ratio of deuterium to hydrogen to be 15 parts per million. This stands as a lower limit to the amount produced in the early universe because deuterium is destroyed over time by the nuclear processes in stars.

The important characteristic of the ratio is that it determines the maximum amount of material that can exist in the universe. Linsky found that the amount of normal matter in the universe is about 10 times too small to halt the expansion of the universe. Unless large numbers of exotic, high-energy particles or unknown forms of matter exist, the universe will expand forever.

Other HST research also focused on the chemistry of the early universe. Douglas Duncan of the Space Telescope Science Institute described how he investigated the oldest stars in the Milky Way, halo stars that contain fossil elements like those in existence in the earliest days of the universe. Duncan targeted the 15-billion-year-old star HD 140283, a yellowish, 7th-magnitude star in Libra that is one of the oldest stars known.

Duncan found the star contains boron and beryllium, rare primordial elements. The puzzling question centers on where these elements came from. Cosmic rays appeared to be the easiest answer, but Duncan found the abundances in the stars did not agree with those that should be observed if cosmic rays were the culprit. The resulting hypothesis is that boron and beryllium were synthesized during the first moments of an inhomogeneous universe.

Two teams of astronomers used HST to probe the inner sanctums of powerful, distant galaxies. Tod R. Lauer of the National Optical Astronomy Observatories led a group that has studied the giant elliptical galaxy M87 in Virgo. Lauer found strong circumstantial evidence that the galaxy contains a supermassive black hole in its center that must contain at least 2.6 billion solar masses. Astronomers have long studied the jet of material shooting out of the galaxy's nucleus, and have hypothesized that a central "engine" must be powering this jet.

An image made by Lauer with the Wide Field/Planetary Camera (WF/PC) clearly shows that stars in M87 become densely concentrated toward the galaxy's center, forming a bright cusp of light at the heart of M87. The density of stars near this cusp is 300 times greater than that expected in a normal elliptical galaxy. Comparison with theoretical models shows that a massive black hole must inhabit the center of the galaxy.

Another powerful emitter of energy, the radio galaxy Perseus A (NGC 1275), is the focus of a study by Jon Holtzman of Lowell Observatory and a group of associates. Using the WF/PC, the team imaged the galaxy's center and found 50 bright objects that appear to be young, massive, bluish globular clusters. "Such objects have never before been seen," says Holtzman, referring to the fact that all other known globulars are old objects found in the haloes of galaxies. Previous observations suggest that two galaxies collided, forming the unusual structure of Perseus A. Holtzman's observations indicate the collision sparked the formation of globular clusters from young, hot stars.

Cepheids Point to the Hubble Constant. How large is the universe? This is a question astronomers have asked from the beginning of astronomy. The most accurate technique for determining distances to nearby galaxies in recent times is measuring the apparent brightnesses of Cepheid

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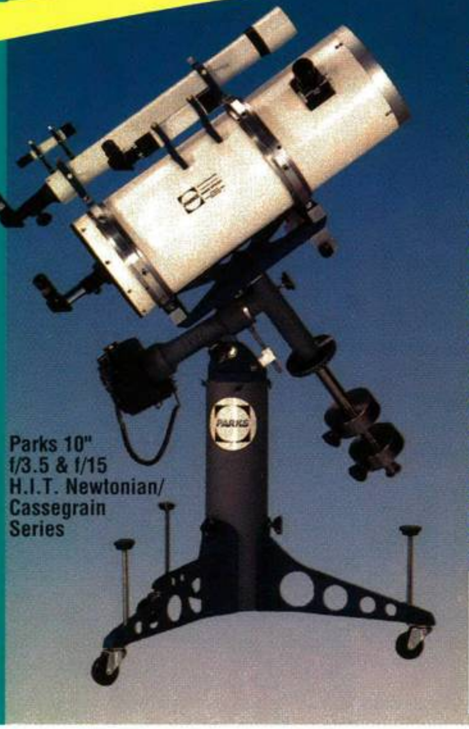

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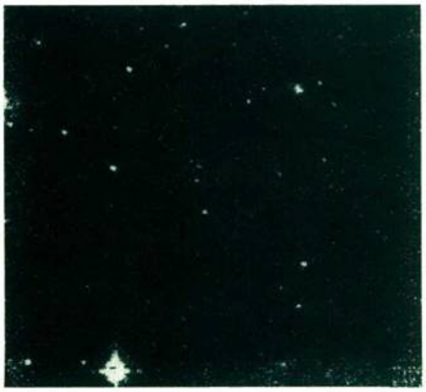
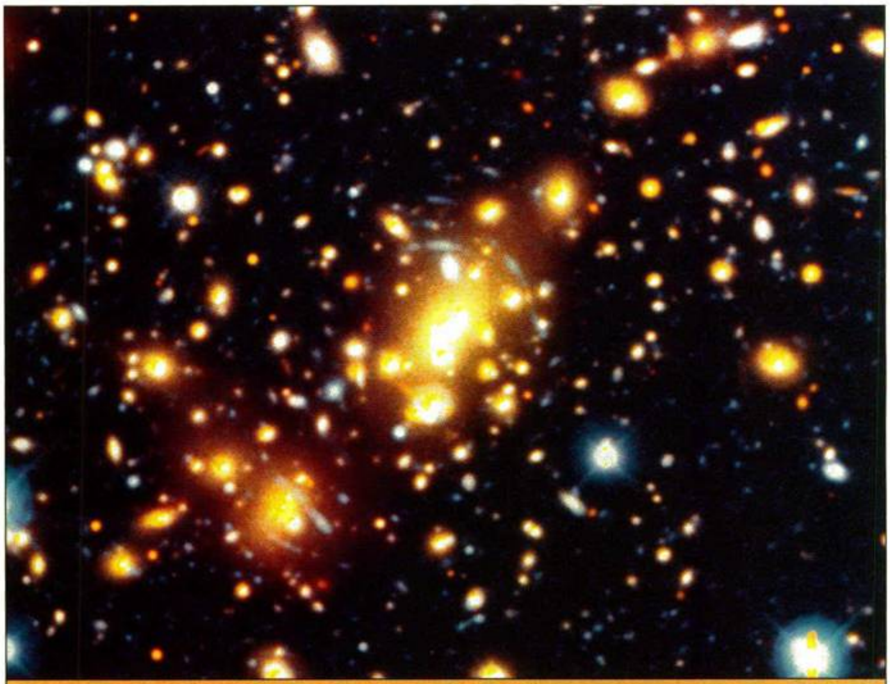
variable stars. Their precise variability and absolute brightnesses make them valuable and dependable "standard candles." The challenge is that very distant Cepheids are too faint to detect. A high-precision study by Wendy Freedman of the Carnegie Observatories and Barry F. Madore of Caltech has produced a new calibration of other distance indicators that leads to a determination of the Hubble Constant, the expansion factor that translates into distance scales in the universe.

Freedman and Madore studied five spiral galaxies — M31, M33, M81, NGC 300, and NGC 2403 — and found accurate distances ranging between 2.5 and 11 million light-years. Although Cepheids are too faint to be detected in distant galaxies (that would enable a direct measurement of the Hubble Constant), Freedman and Madore calibrated the relation between the galaxies' luminosities and their rotational speeds. This leads to a Hubble Constant of 85 km/sec/Mpc, which lies toward the high end of the range astronomers generally believe to be true.

Such a high figure for the Hubble Constant provides astronomers with an unsettling problem. The age of the universe would be no more than 12 billion years, but astronomers have observed stars older than this. This also potentially throws a monkey wrench into ideas about how galaxies form. If the Freedman-Madore data are correct, astronomers may have to rethink their conclusions about the age of the universe and theories of galactic evolution.



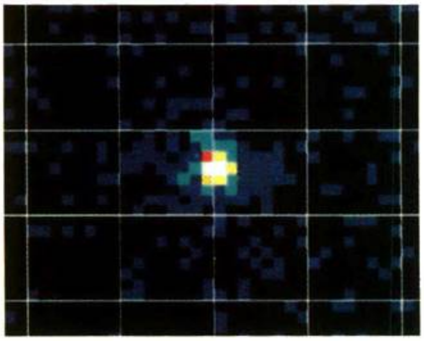
CEPHEID VARIABLES (dots in field) in galaxies *like NGC 4182 led* Wendy Freedman and her colleagues to arrive at a Hubble Constant of 85 km/sec/Mpc. NOAO.



THE DISTRIBUTION OF DARK MATTER in galaxy cluster A2218 is visible in this unique photo. The yellow objects are galaxies at a distance of about 2 billion light-years. The bluish arcs in the cluster represent the light from more distant galaxies warped into arcs by the dark matter within the foreground cluster. Photo courtesy Gary Bernstein, Tony Tyson, and NOAO.

Compton's Distant, Powerful Gamma Rays. The Compton Gamma Ray Observatory, launched in April 1991, continues to provide scientists with surprising information on gamma-ray emitting objects in the universe. The study of gamma-ray objects is in its infancy: astronomers using Compton's Burst and Transient Source Experiment (BATSE) are only now finishing their basic survey work mapping gamma-ray sources. "Over 210 gamma-ray bursts have now been detected," says Gerald Fishman of NASA's Marshall Space Flight Center. "And we're finding that the distribution of these sources is strongly isotropic." The data show that gamma-ray sources are spread randomly over the sky, rather than concentrated in any specific area. It is highly unlikely that these energetic sources are very close, so the early indication is that these are very powerful, very distant objects. (See "Bursting with Surprises" by Richard Talcott, March 1992 issue.)

In addition to reporting on mapping gamma-ray sources, Fishman announced the discovery of a new gamma-ray pulsar, the third such object known. The first such object was discovered in 1969, the second in 1975. Fishman's object, known as PSR 1509–58, is also called the Circinus Pulsar. "The period is 151 milliseconds, so we see about 400 bursts per minute," Fishman says. "While the other two gamma-ray pulsars emit two pulses for every rotation



A BRILLIANT GAMMA-RAY EMITTER, quasar 3C 279 shines in this image made with the Compton Gamma Ray Observatory. The quasar has brightened in the gamma-ray region over the past nine years; once invisible it is now one of the most brilliant objects in the universe. NASA image.

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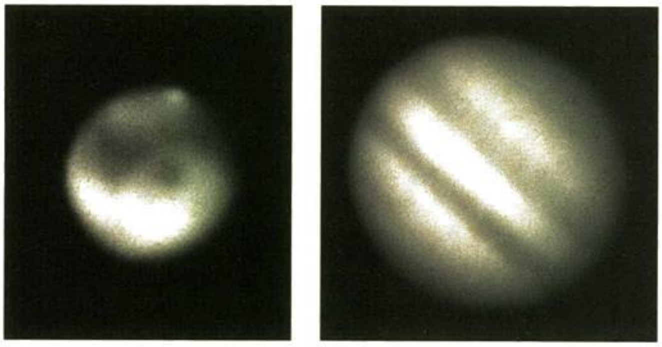

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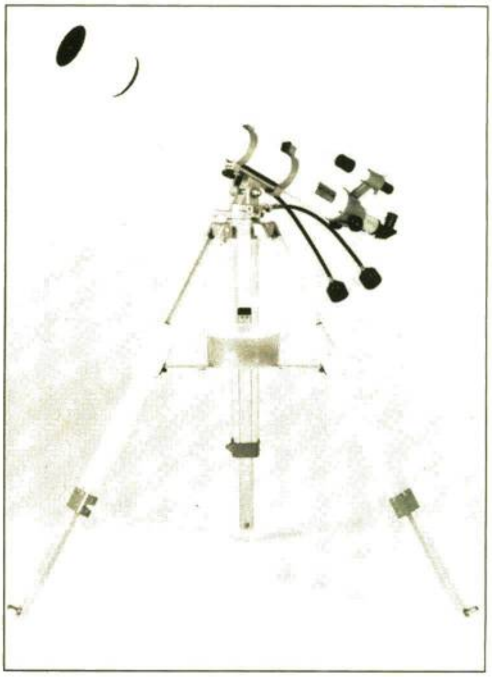

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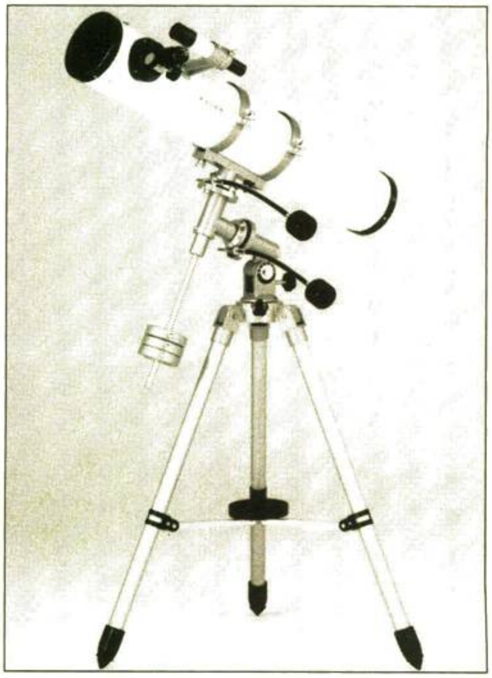

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period, indicative of the two magnetic poles of a neutron star, the Circinus Pulsar has only a single pulse for each rotation. The reason for this, as yet unknown, may help to explain how the pulses are produced."

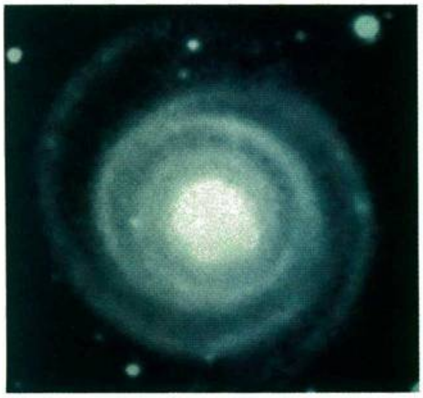
Compton astronomer Carl Fichtel announced the detection of extremely distant and powerful gamma-ray sources. Four powerful quasars, 3C 279, 4C–38.41, PKS 0208–512, and PKS 0528+134, are among the most distant and energetic objects known. "For example, 3C 279 undergoes 20-day-long surges of gamma-ray activity," says Fichtel. "During this period the object emits 10^{48} ergs/sec in gamma rays alone, which is equal to 1,000 times the radiation emitted by the Milky Way Galaxy in one second in all wavelengths."

"Leading arm" Galaxy Discovered. Astronomers from the University of Alabama announced their discovery of a unique object, the first example of a leading-arm galaxy. Designated NGC 4622, the galaxy is an Sa-type spiral in Centaurus that lies at a distance of some 140 million light-years. The galaxy has arms that appear to wrap in different directions, the inner arms trailing one way and the outer arms the other. In actuality, a leading arm galaxy forms when the inner arm wraps outward from the galaxy and forms a ring. This creates the illusion that the inner arms are not trailing the rotating nucleus, but leading it.

"This is the first observationally convincing case of a leading arm spiral," says astronomer Ronald Buta. "It has been bandied about for decades whether these things actually exist, and now we know they do." Galactic interaction is the suspected culprit. An encounter with another galaxy in the past may have caused the gravitational tug on the inner arms that resulted in the peculiar structure. The leading arm shape is made possible by and perpetuated by a huge halo of dark matter that surrounds the galaxy.

Pleiades Wake Imaged. The Pleiades is one of the most observed star clusters in the sky, but two astronomers in Atlanta were more concerned with the cluster's path through the Galaxy than its pretty structure. Richard E. White of Smith College and John Bally of AT&T Bell Laboratories are the first scientists to create an image of the wake of the cluster through the interstellar medium. The astronomers used images from the Infrared Astronomical Satellite, which shows bright infrared emission in the vicinity of the Pleiades. The energy emitted from the hot cluster stars and absorbed by nearby dust grains warms the grains so they glow in the infrared.

The unique feature of the image is the dark "tunnel" that stretches away from the Pleiades cluster to the east. This hole measures some 10 light-years long and is flanked by bright ridges of infrared emission on the northern and southern edges of the tunnel. This tunnel is the area swept clean by the Pleiades cluster as it travels at supersonic speeds through the tenuous dust and gas of interstellar space. It is the first such image produced of the Pleiades cluster. By studying the



THE FIRST OF ITS TYPE, "leading arm" galaxy NGC 4622 in Centaurus. Its inner arms rotate one way and outer arms rotate the other. Astronomers Ron Buta, Gene Byrd, and Deborah Crocker believe this resulted from an encounter with another galaxy. University of Alabama photo.

Amateur News

MAY 9: ASTRONOMY DAY 1992

What would you do if you saw "Alf" and a "man in the moon" sitting atop a classic Corvette? Probably stop and see what's going on. That's just what thousands of people in Lake Arrowhead, California, did on April 20, 1991. The occasion was the Mountain Skies Astronomical Society's 1991 Astronomy Day program. Visitors who stopped found the club's 30,000-square-foot exhibit with dozens of astronomy displays. They also met a shuttle astronaut, Joe Engle. Some visitors went away with a piece of a space rock (a meteorite) or a taste of astronaut ice cream. The club's efforts not only netted them good community relations, they also picked up 17 new members.

Such is the excitement that surrounds Astronomy Day. A recent poll by ASTRONOMY magazine indicates that 1991's Astronomy Day saw over 150 sites in the United States and Canada host some type of public event. The actual figure may be closer to twice that many.

On the East Coast of the continent, at the Hayden Planetarium in Boston, there was so much going on at their 1991 Astronomy Day program they had to set up four remote sites at local libraries. A thoughtful feature of Boston's program was special activities for the hearing and visually handicapped.

At Buffalo, New York, the Buffalo State Astronomical Society had rain and more rain, but that didn't dampen the spirits of 75 people who opted to leave the dry, warm indoor displays and venture out on a guided tour of a scale model of the solar system. Needless to say, their indoor activities were filled beyond capacity.

Up in Canada, the Toronto Centre of the Royal Astronomical Society of Canada held a 12-day long "Astronomy Week" including a weekend shopping mall display. Like the group in Boston, they held events at many different sites (eight to be exact).

At dozens of libraries, museums, planetariums, science centers, nature centers, parks, and just plain street corners, hundreds of astronomers treated thousands of passers-by to the wonders of the universe, an experience they won't soon forget. Your chance to participate in Astronomy Day this year comes on Saturday, May 9. Check with the club or planetarium in your area (listed in the Astronomy Directory in this issue) to see what they have planned. — *Gary Tomlinson, Astronomy Day Coordinator, 54 Jefferson SE, Grand Rapids, MI 49502, (616) 784-9518.*

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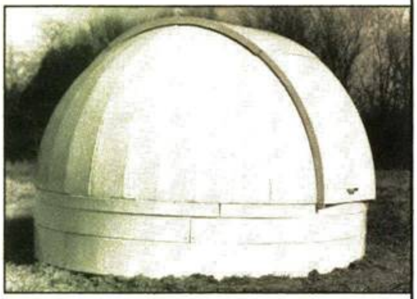

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ASTRONOMICAL LEAGUE

THE INTERSTELLAR WAKE of the Pleiades star cluster can be seen in this far infrared image as a dark hollow between the cluster and the left side of the frame. The cluster's wake is surrounded by clouds of dust, dimly illuminated in this image. Photo courtesy Richard E. White, Smith College.

image, the astronomers will be able to trace the motion of the dust cloud backward, which preliminarily suggests it formed about 15 million years ago, in an area toward the constellation Vulpecula.

Supernovae are Common! Supernovae, the explosive deaths of massive stars, are far more common than astronomers have previously believed. That is the conclusion put forth by Saul Perlmutter of the Lawrence Berkeley Laboratory, who conducted an automated supernova search experiment consisting of electronic cameras that recorded supernova explosions. In their survey group, Perlmutter's team found 20 supernovae, most of them in the last three years. This suggests that supernovae occur in normal spiral galaxies like the Milky Way at least once every 30 years, and maybe more often.

The greatest increase over previous estimates came with Type Ic supernovae, which result from the collapse of the core of a dying star. More than half of the supernovae in the survey were Type Ic objects. "These results are encouraging because they suggest we could have a supernova in the Milky Way in the near future," says Richard Muller, a research associate of Perlmutter's. A Milky Way supernova notwithstanding, increasing use of automatic imaging equipment is helping astronomers better analyze the statistics of supernovae and their overall effects on galaxies.

LSB Galaxies: Keys to the Past. Increasingly, astronomers are finding that gravitational interaction between galaxies triggers star formation. At what rates, then, do isolated galaxies form stars? The question is central to research on giant low surface brightness (LSB) galaxies being conducted by Patricia M. Knezek of the University of Massachusetts. Knezek has found that these large, faint, massive galaxies rarely have neighbors, and so is studying their star-formation histories. She believes that these galaxies form stars very gradually. "If this is true," proclaims Knezek, "this population could represent a valuable window into the early epochs of star formation in disk galaxies."

Another study of LSB galaxies shows they have very low metallicities, meaning they are made almost exclusively of hydrogen and helium. Stacy McGaugh of the University of Michigan and coworkers feel this is significant evidence that supports how LSB galaxies may be a window to the distant past. "The low metallicities of ionized gas in the LSBs indicate that this gas is still in its original, pristine state," says McGaugh. "It's been sitting relatively untouched since the Big Bang 15 billion years ago." Inconspicuous, not particularly attractive, and without normal galactic evolution, LSB galaxies may nonetheless prove to be a significant topic in the future years of astronomical research. — *David J. Eicher*

Space News

ULYSSES AT THE TURNING POINT

On February 8, 1992, Jupiter received its first visitor in over 12 years. Ulysses, a spacecraft built by the European Space Agency (ESA) and operated jointly by ESA and NASA, paid a quick visit to the giant planet. At closest approach, Ulysses passed 235,600 miles from Jupiter's cloudtops, a separation equal to the distance between Earth and the Moon.

The Jupiter flyby was critical to the Ulysses flight — mission planners used Jupiter's powerful gravity to fling Ulysses below the plane of the solar system for an eventual look at the south pole of the Sun. "The spacecraft is in good shape," project manager Derek Eaton proclaimed after the Jovian encounter — Ulysses left the planet aimed precisely in the right direction and none the worse for traveling through Jupiter's intense and potentially damaging radiation belts.

But the Ulysses flyby of Jupiter produced more than just a change in the trajectory of the spacecraft. Ulysses' battery of instruments explored the Jovian magnetic field, a region that pulses with 100 billion kilowatts of energy. Though Pioneers 10 and 11 and Voyagers 1 and 2 all had flown past Jupiter before, Ulysses took a different slice through the magnetic field, passing above the north pole of the planet then exiting below the south pole. This gave astronomers a new angle on the region surrounding Jupiter.

"Ulysses is making a major contribution to Jupiter science," says Ed Smith, U.S. project scientist for Ulysses. Among the findings: the magnetosphere, the region occupied by Jupiter's magnetic field, was much larger than it was in 1979 during the Voyager encounters. During the Ulysses encounter, it extended out to 110 Jupiter radii (nearly 5 million miles) on the sunward side of Jupiter, twice as far as the Voyagers had found.

The Jovian magnetic field is not a spherical halo around the planet but is much more flattened than expected. There is little trapped radiation over the high latitudes of Jupiter (above 50° north and south latitudes), a discovery Peter Wenzel, program scientist for the European Space Agency, calls "the biggest surprise of the Ulysses encounter."

Within the magnetic field is a giant doughnut-shaped cloud of charged sulfur and oxygen atoms that circles Jupiter, the so-called Io plasma torus. Though its existence was known, Ulysses showed that the torus is not a smooth doughnut but is very patchy, with six hot spots along its circumference at the time of the encounter. This plasma torus is fed by material thrown into space from volcanoes on the surface of Io, Jupiter's large inner moon. When Ulysses observed it, the Io torus was only half as intense as it was when the Voyagers flew past Jupiter, suggesting that the volcanic activity on Io has declined over the last decade. Thanks to Ulysses, scientists think they can now monitor the level of Io's volcanic activity from Earth by observing the variations in the radio emissions from the plasma torus. ☐

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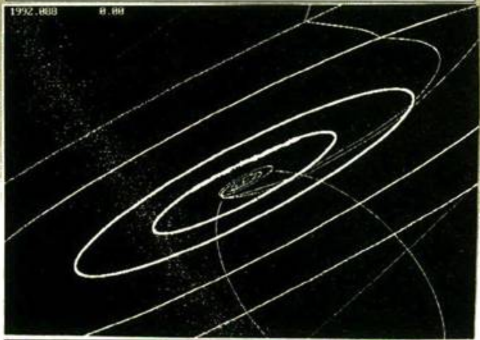

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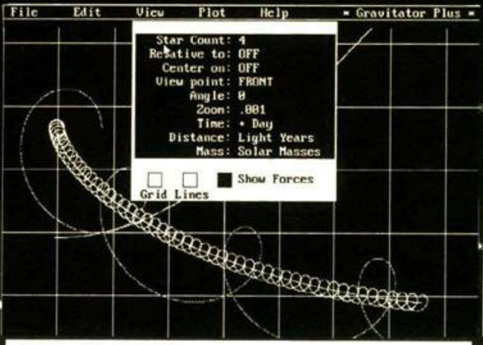

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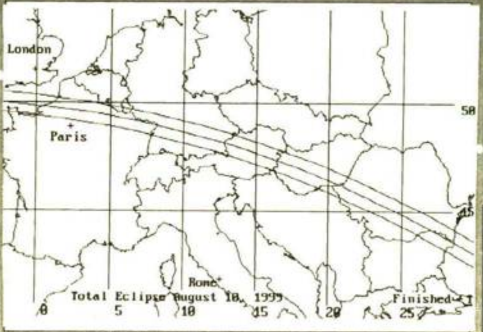

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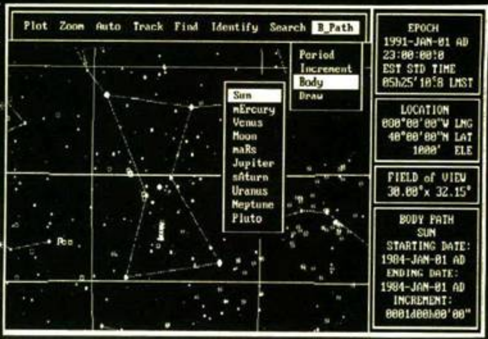

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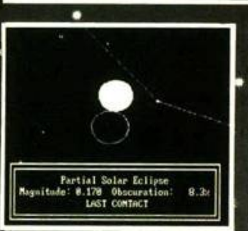

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Partial Solar Eclipse
Magnitude: 0.170  Obscuration:  8.3%
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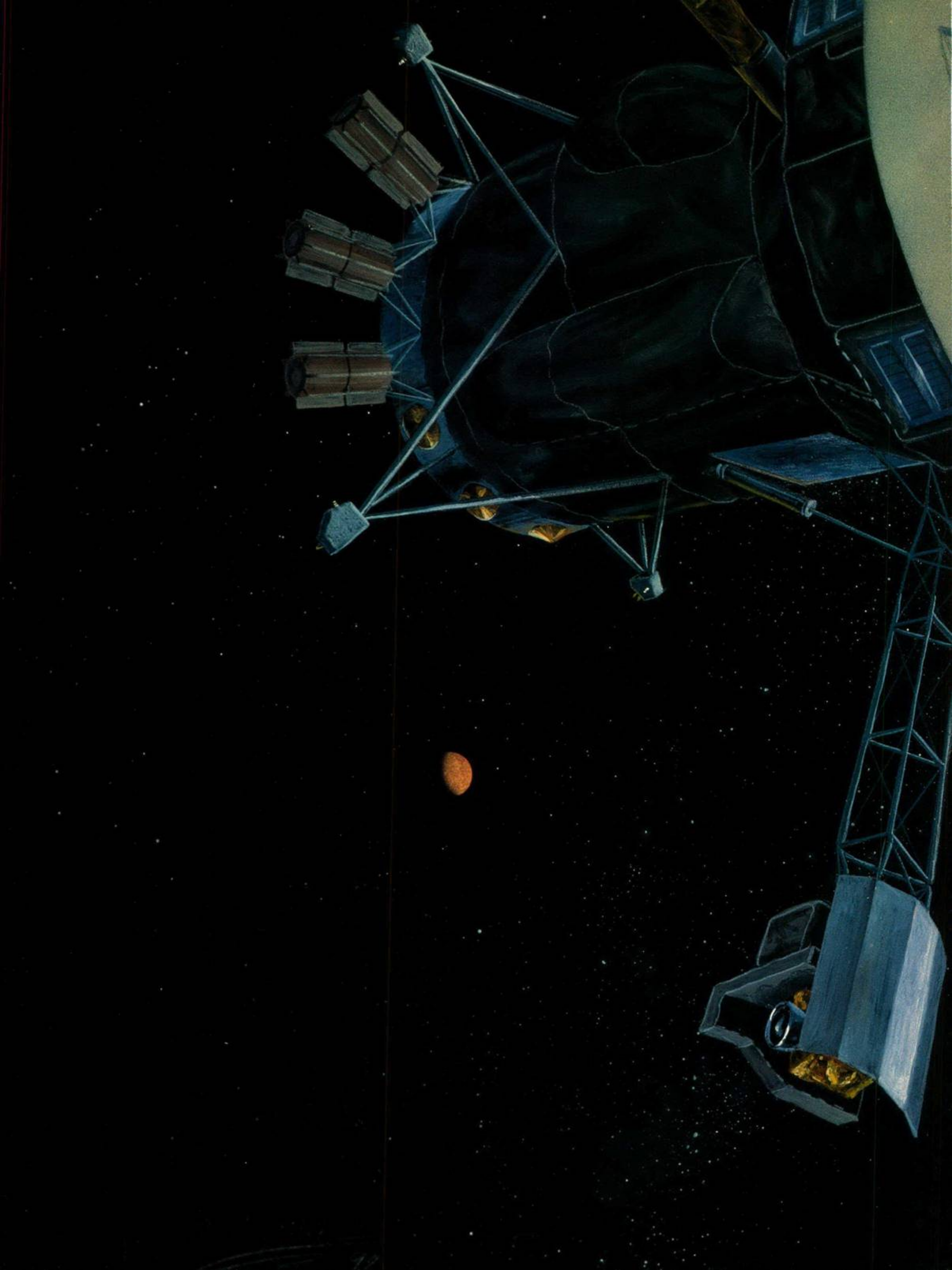
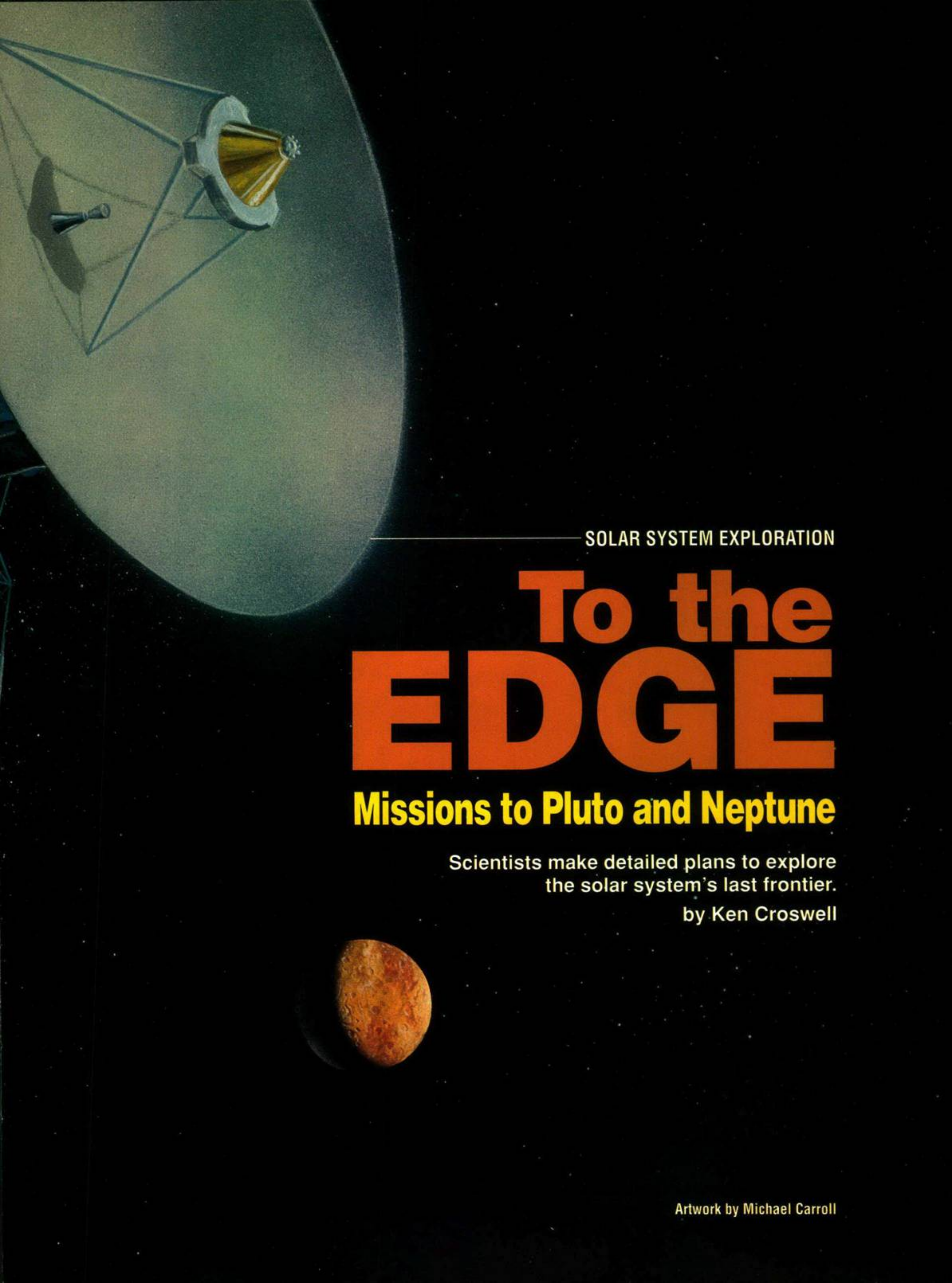




SOLAR SYSTEM EXPLORATION

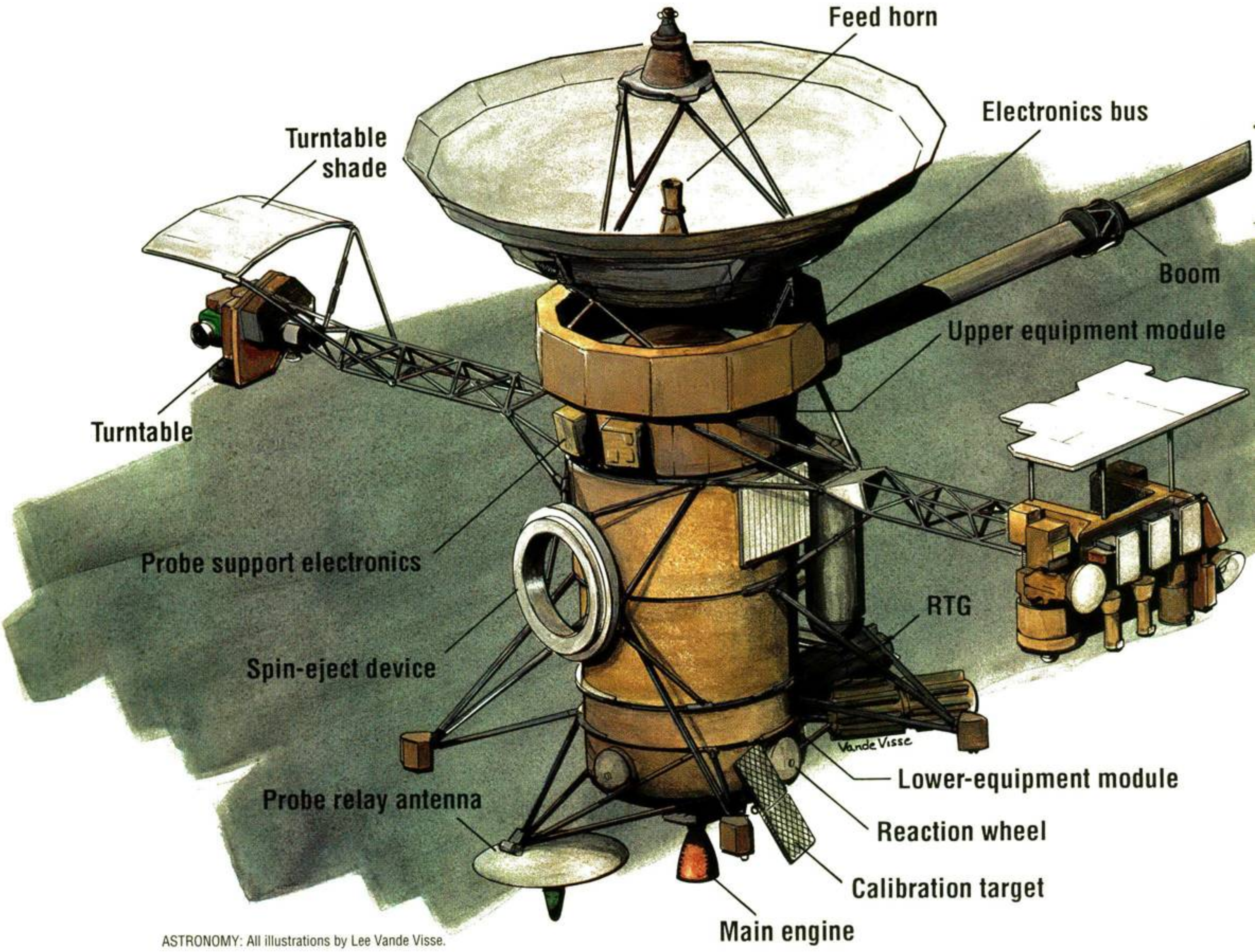
To the EDGE

Missions to Pluto and Neptune

Scientists make detailed plans to explore the solar system's last frontier.

by Ken Croswell

Artwork by Michael Carroll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Calibration target
Main engine

ASTRONOMY: All illustrations by Lee Vande Visse.

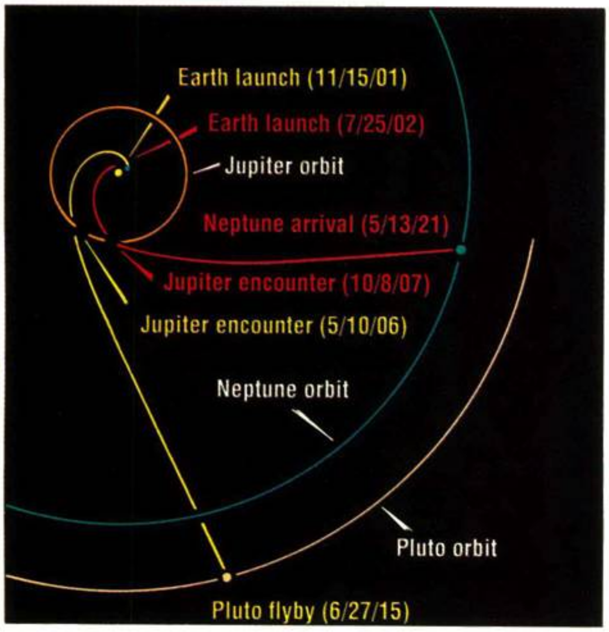
Pluto. No spacecraft has ever flown past it, no instruments have ever sampled its atmosphere, no cameras have ever ventured near its forbidding surface. More than three billion kilometers away, Pluto patrols the outer reaches of the solar system, guards its secrets well, and challenges us to explore it.

Journeys to the Edge of the Solar System

In 1989, the Voyager 2 spacecraft sped past two other distant worlds, Neptune and its big moon Triton. Voyager discovered an Earth-sized dark spot on Neptune and erupting geysers on Triton, but the visit was brief, and Voyager is now heading out of the solar system, never to return. All three worlds — Neptune, Triton, and Pluto — figure prominently in plans for bold new missions to the outer solar system. They are missions of daring and imagination, missions that will send a spacecraft past Pluto in 2015 and an orbiter to study Neptune and Triton around 2021.

Of the three principal targets for such flights, Neptune is by far the largest. Measuring 49,530 km across, it dwarfs the small, rocky planets of the inner solar system. It is a giant world, like Jupiter, Saturn, and Uranus. But these four planets differ greatly among themselves. For one thing, Jupiter and Saturn contain much more mass than Uranus and Neptune. Jupiter's mass is 318 Earths and Saturn's is 95 Earths, but Uranus and Neptune have masses of only 14.5 and 17.2 Earths. All four giant planets have hydrogen-helium atmospheres engulfing cores made of water and rock. For Jupiter and Saturn, the hydrogen-helium atmosphere is so thick that it constitutes most of each planet's mass. For Uranus and Neptune, the reverse is true: the core of water and rock outweighs the hydrogen helium atmosphere enveloping it. Thus, Uranus and Neptune are fundamentally different from Jupiter and Saturn.

The differences among the four big planets will be a crucial target of inquiry for several spacecrafts.



THE PLUTO-NEPTUNE MISSIONS might use a Mariner Mark 2 spacecraft similar to the one planned for the Cassini mission.

Jupiter and Saturn will be the first to greet the next visitors to the outer solar system. In 1995, the Galileo spacecraft will reach orbit around Jupiter and send a probe into Jupiter's thick atmosphere. In 2002, the Cassini spacecraft will orbit Saturn and hurl a probe into the atmosphere of that planet's large moon Titan. Both Jupiter and Saturn have already received flybys from spacecraft, but orbiters such as Galileo and Cassini will yield far more data, since they can examine their targets for years. Such detailed studies promise exciting revelations. But because the masses and structures of Jupiter and Saturn differ so much from those of Uranus and Neptune, we will not be able to infer much about these planets from Galileo and Cassini.

Uranus and Neptune also distinguish themselves from their big brothers in other ways. First, the two planets look different. Methane gas on Uranus and Neptune absorbs red light to varying degrees, coloring Uranus green and Neptune blue. Moreover, Uranus is bland, whereas Neptune has a lively atmosphere. In 1989, Voyager 2 discovered Neptune's Great Dark Spot, an Earth-sized feature that resembles Jupiter's even larger Great Red Spot. Scientists would like to study Neptune's atmosphere for years rather than days, the way Voyager did. They can then see which atmospheric features change and which endure.

Orbiting Neptune are four rings and eight satellites. The king of the satellites is Triton, but the seven smaller moons are also of interest, for Voyager did not study them up close. Take, for example, the second largest satellite, Proteus, which Voyager itself discovered. Proteus measures only 400 km across but bears a crater 150 km wide. Also intriguing is Neptune's third largest moon, Nereid, which American astronomer Gerard Kuiper discovered in 1949. Nereid follows an elongated orbit around Neptune. When nearest the planet, Nereid lies 1.4 million km from Neptune, but when farthest Nereid ventures 9.7 million km from its master. Unfortunately, Nereid lay far from Voyager 2 when the spacecraft passed it, and the best Voyager image shows Nereid as only a fuzzy crescent.

By far the most intriguing satellite, though, is Triton. With a diameter of 2,700 km, Triton is Neptune's largest moon. It is also one of the largest moons in the solar system, ranking seventh in size. Of these big moons, Triton lies farthest from the Sun and has a temperature of just 38 kelvins, the coldest ever measured in the solar system. For comparison, Neptune is 59 kelvins. When Voyager flew by in 1989, it discovered that over 99 percent of Triton's tenuous atmosphere is nitrogen, the same gas that makes up most of the atmospheres of Earth and Saturn's moon Titan. Voyager 2 also found a huge polar cap on Triton composed of nitrogen and methane ice and what appear to be geysers shooting nitrogen gas 8 km high into the atmosphere. Other areas of Triton contain volcanoes. Though probably no longer active, these volcanoes may have flooded Triton billions of years ago, not with lava, but with liquid water that buried most of Triton's craters. As a consequence, Triton is one of the few moons in the solar system that is not heavily cratered.

Such intense volcanism tells scientists that Triton has led a rough life. Triton has suffered because it did not form with Neptune but was instead captured by it. We know Triton is captured because it orbits Neptune backward, opposite the direction that Neptune spins. Triton is the only large moon in the solar system to circle its planet backward. After Triton was captured, its orbit around Neptune was elliptical, like Nereid's present orbit. But friction with Neptune's atmosphere and the tides raised on Triton by Neptune reduced the ellipticity of the orbit so that today the satellite's orbit is a circle. This circularization exacted a huge price from Triton, however, for Triton's interior heated so much — by transfer of kinetic energy to heat — that it completely melted. Volcanoes spewed water out of the satellite's interior, eradicating Triton's craters. These volcanoes may also have erupted the nitrogen and methane ice that now lie over the satellite's crust, which itself is made of water ice.

Several objects like Triton may have clumped together long ago to form the planet Triton now orbits. When the solar system was young, Triton-like objects and small, icy comets collided with one another to form Uranus and Neptune. Therefore, Triton is a remnant of the building blocks of the solar system and provides insight into the origin of the outermost planets. Unfortunately, because of the trauma it suffered following its capture by Neptune, Triton no longer resembles its original self. What we now see on its surface may be as much a product of Triton's unique history as of its birth.

The Planet Double

Fortunately, there is also Pluto. In all ways but one, Pluto appears to be just like Triton. Pluto is the same size (2,300 km across for Pluto, 2,700 km for Triton), the same density (2.03 grams per cubic centimeter for Pluto, 2.07 grams per cubic centimeter for Triton), and therefore probably has the same composition. Like

Triton, Pluto harbors methane ice on its surface and is surrounded by a tenuous atmosphere. As Triton once did, Pluto orbits the Sun independent of Neptune. The big difference, though, is that Pluto never got caught by Neptune, so Pluto escaped the geological changes that Triton suffered. Both Pluto and Triton are building blocks dating back to the origin of the solar system. But unlike Triton, Pluto may preserve a record of the solar system's origin 4.6 billion years ago. That is a big reason scientists want to see Pluto.

The best reason to send a spacecraft to Pluto, though, is that no one ever has. A mission to Pluto would show us for the first time what Pluto is like, revealing what substances lie on its surface and what gases constitute its atmosphere. It would also scrutinize Pluto's odd moon, Charon, discovered in 1978. Even less is known about Charon than Pluto. Charon measures about 1,200 km across, a little over half the diameter of Pluto itself. For comparison, Triton is just one-eighteenth the diameter of Neptune. Charon is so big relative to Pluto that many scientists call Pluto and Charon a double planet.

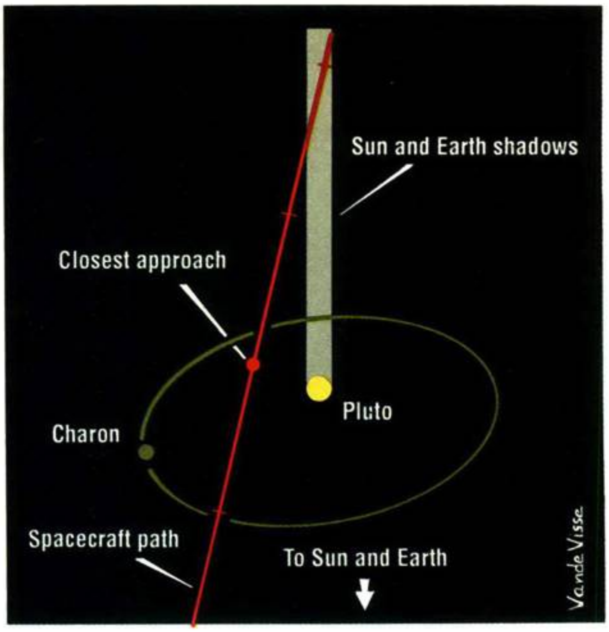
Mysterious though it is, Charon has shown that Pluto resembles Triton. In 1978, Charon's slow orbital motion around Pluto revealed that Pluto's mass is tiny, far less than that of any other planet. Furthermore, from 1985 to 1990, astronomers observed eclipses as Pluto and Charon passed in front of and behind each other. These eclipses revealed Pluto's diameter. The two pieces of data — mass and diameter — yielded Pluto's density, showing that Pluto is probably made of the same stuff as Triton. Although they have led radically different lives since birth, both Triton and Pluto hold key clues to the origin of the outermost planets.

Why Now?

Neptune, Triton, and Pluto deserve spacecraft. They are objects of importance, worlds of mystery. To reach Neptune and Pluto fast, however, a spacecraft must first fly past Jupiter, whose great gravity can accelerate a craft to the edge of the solar system. Jupiter circles the Sun every 12 years and so is in the right place about once every 12 years. Therefore, launch opportunities to Neptune and Pluto recur at the same interval. The next launch windows open from 2001 to 2003. If we miss them, we must wait more than a decade and launch in 2013. For Neptune, such a delay would not be a problem. Neptune and Triton will not change greatly in 12 years, so they can wait.

But Pluto cannot. Pluto follows the strangest orbit of any planet, one that takes the world from just inside Neptune's orbit to two billion kilometers beyond it. Right now, Pluto is closer to the Sun than Neptune is. In 1979, Pluto equaled Neptune's distance from the Sun, in 1989 it achieved its closest distance to the Sun, and in 1999 it will slip back beyond Neptune. Pluto is therefore receding from the Sun and getting colder. Astronomers calculate that by the 2020s Pluto will be so cold that its atmosphere will freeze onto the surface and remain frozen for nearly two centuries. A Pluto-bound craft launched in 2001 would reach Pluto in 2015, before the atmosphere vanishes, but one launched in 2013 would get there at the end of the 2020s, too late to determine what gases make up Pluto's atmosphere.

Furthermore, not only will Pluto's atmosphere soon disappear, but so will our view of half of Pluto itself. Like Uranus, Pluto lies on its side as it rotates. During the 1980s, Pluto's equator faced the Sun and all of Pluto and Charon received sunlight during a complete day. A spacecraft that flew past Pluto and Charon at that time would therefore have seen all of both worlds, since Pluto and Charon would have been fully illuminated for the spacecraft's cameras.



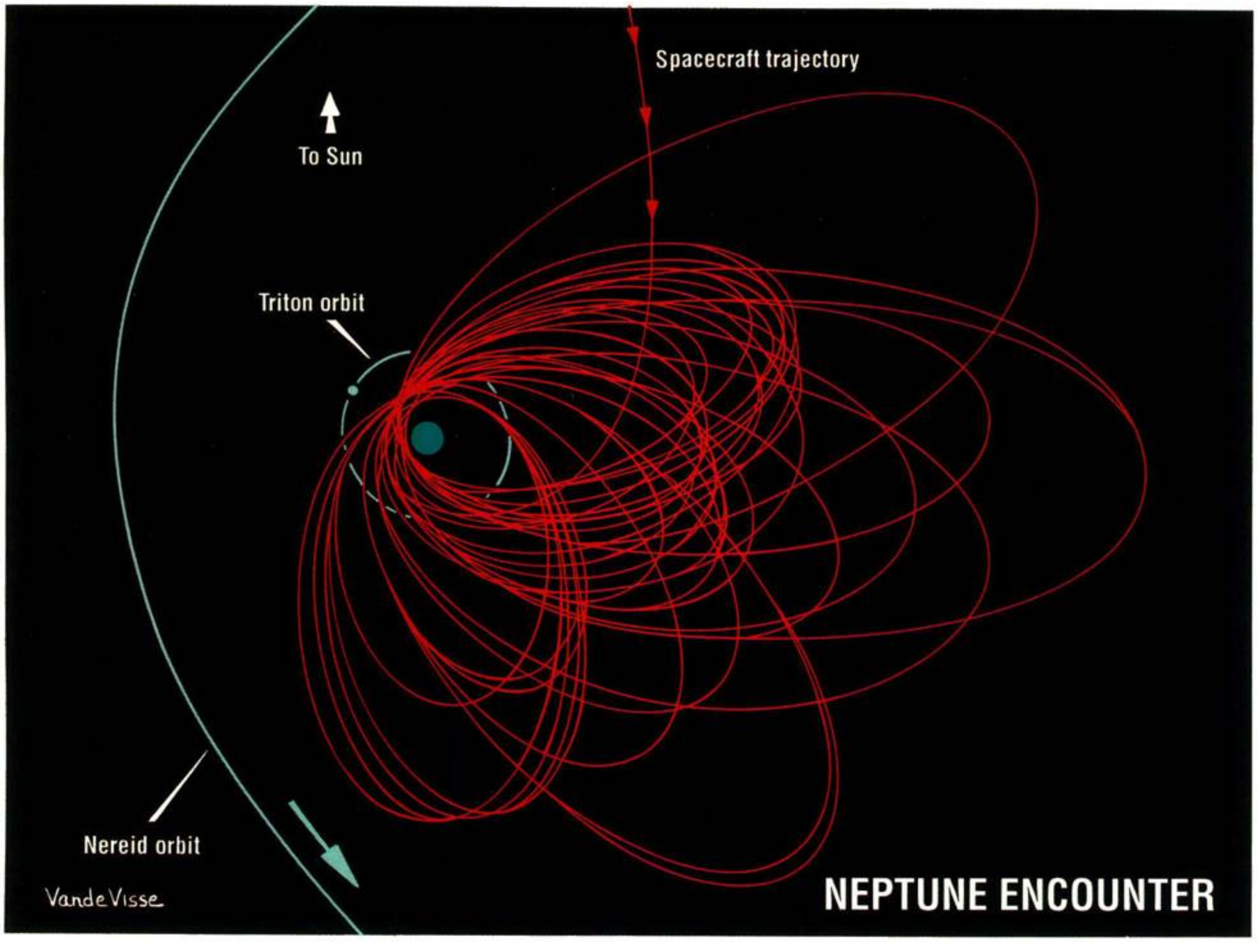
THE PLUTO AND NEPTUNE ENCOUNTERS will occur on June 27, 2015, and May 13, 2021, respectively, after the spacecraft journey to the depths of the solar system.

But Pluto is moving into a position such that one of its poles faces the Sun, leaving the other side in perpetual darkness. A spacecraft launched in 2001 would arrive soon enough to image most of Pluto and Charon, but a spacecraft launched in 2013 would reach Pluto and Charon too late to study much more than half the surface of each. A similar situation actually prevailed in 1986 when Voyager 2 flew past Uranus. The pole of Uranus faced the Sun, so the spacecraft could photograph only half of Uranus because the other half was dark. In the case of Uranus, this wasn't a big deal: Uranus is bland, and one side probably looks like the other. But Pluto's surface is much more variable. Astronomers know this because Pluto's brightness changes by nearly 30 percent every time the planet rotates. It would be unfortunate if the Pluto spacecraft traveled three billion kilometers and then missed seeing half the planet.

Close to the Edge

What will the journey to the far-off worlds of Neptune and Pluto be like? Even the scientists and engineers most involved with the missions don't know for sure. They have only just begun to formulate the flight plans, so details may change. No funding has begun, nor need any be requested until the mid-1990s. So preliminary are these missions, in fact, that the Neptune- and Pluto-bound craft have not yet been named.

To save money, the Neptune and Pluto spacecraft will be similar, even though their targets are not. Both spacecraft will probably be Mariner Mark 2s, a design to be used on the Cassini mission to Saturn. Both



spacecraft will also have probes attached to them, just as Galileo and Cassini do. Mariner Neptune will send its probe into Neptune's atmosphere, and Mariner Pluto will use its probe in such a way that all sides of Pluto and Charon can be mapped at close range. Employing similar spacecraft and borrowing technology from Cassini will cut costs, but such an ambitious project will still be expensive. The total price tag for the Neptune-Pluto missions will likely be at least a billion dollars. Funding must begin in fiscal year 1996 or 1997.

The Pluto mission will be launched first, in 2001. That way, if the spacecraft fails, the second spacecraft, originally targeted for Neptune, can go to Pluto. If the first craft leaves Earth safely, however, the second will be launched toward Neptune in 2002. The Pluto craft will reach its target first, in 2015, and head out of the solar system. The Neptune craft will take longer and not achieve orbit around Neptune until 2021. By the 21st century, Neptune will again be closer than Pluto, but a spacecraft that orbits a planet faces a tougher job than one that flies past its target — the orbiter must slow down to the point where it can enter an orbit. Thus, whereas the Pluto flyby craft will take about 14 years to reach its goal, the Neptune orbiter will require 19 years to attain its.

Mariner Pluto

According to the current scenario, the Pluto-bound spacecraft will leave Earth in late 2001. It will be launched on a Titan 4/Centaur rocket, rather than by the shuttle the way Galileo was. The Mariner spacecraft will travel around the solar system and in 2005 re-encounter Earth, whose gravity will send the ship to Jupiter for an encounter in 2006. Jupiter's gravity will then catapult the craft to the edge of the solar system.

Pluto is the real target. In mid 2014, ten months prior to encounter, the Mariner spacecraft will begin observing the far-off world. As the craft approaches, it will discern details on the surfaces of Pluto and Charon. Three to four months before encounter, the Mariner spacecraft will fire its probe. This probe will help the main spacecraft image all of Pluto. Pluto spins slowly, once every 6.4 days, so without a second craft, the speeding Mariner would see only half the planet well. When best placed for observing the other half of Pluto, the spacecraft would lie too far out from the planet. The probe will fly past Pluto 3.2 days either before or after Mariner does. Since 3.2 days is half of Pluto's rotation period, the two ships will photograph opposite hemispheres during closest approach. (Another option scientists are studying is to equip Mariner with such a superb camera that it can study Pluto well even from a great distance. This would eliminate the need for the probe.)

Weeks before the flyby, Pluto and Charon will fill the cameras of the spacecraft. During the encounter, the spacecraft will achieve a resolution of 1 to 2 km across the entire surface, meaning that the spacecraft can see objects that small. This is comparable to the resolution of Voyager's best images of Triton. In places, however, the resolution may be as good as 50 meters, similar to the resolution of the best pictures we now have of Mars from spacecraft orbiting that planet.

For the first time, we will see what Pluto and Charon really look like. Mariner images may reveal polar caps and geysers on Pluto as well as substances other than methane ice on its surface. The spacecraft may find that Pluto resembles Charon or that the two worlds differ radically. In addition, Mariner will search for new satellites orbiting Pluto.

The Mariner spacecraft will skim close to Pluto, perhaps just 3,000 km above the planet's frigid surface. It will not only measure the composition of Pluto's atmosphere from afar but also sample it from within, for the craft will pass directly through Pluto's tenuous upper atmosphere. We already know Pluto's atmosphere has methane, but it may also contain nitrogen or carbon monoxide.

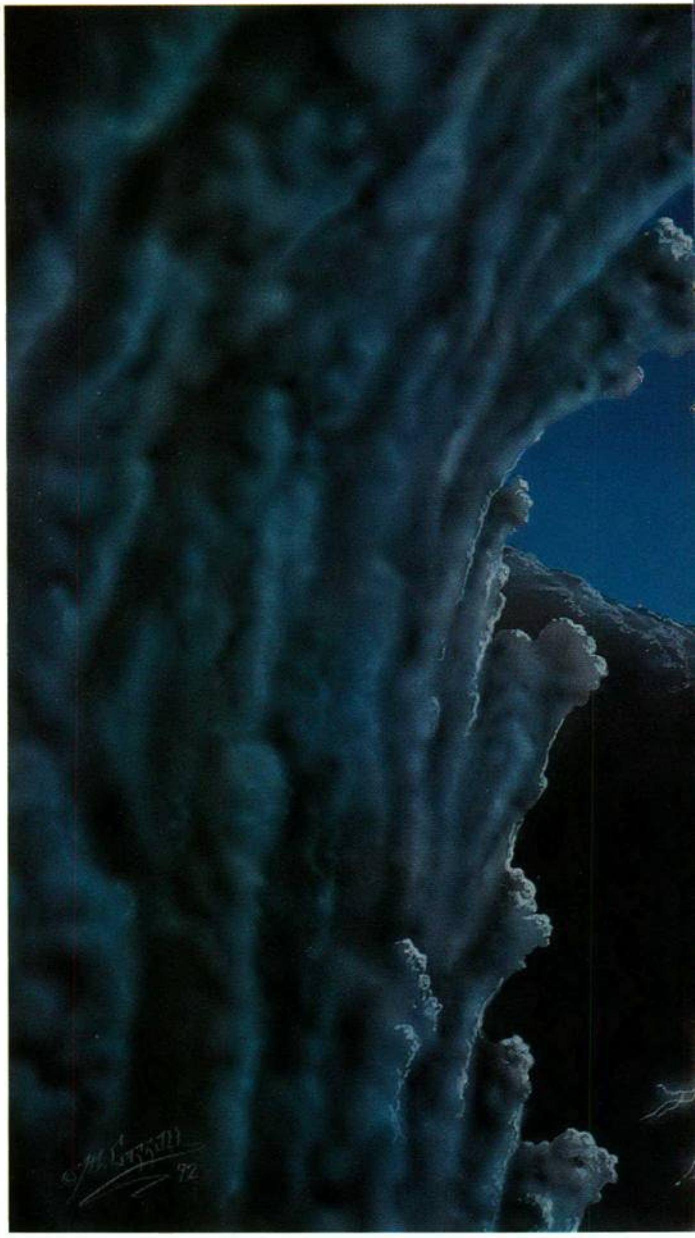
To study Pluto's atmosphere further and to search for one around Charon, the probe will beam radio signals through the atmospheres of Pluto and Charon to the Mariner spacecraft, and Mariner itself will observe Pluto's atmosphere as the spacecraft passes behind the planet. Such studies will give further information on the structure of Pluto's atmosphere. The spacecraft will then race away from Pluto on a course out of the solar system. But Mariner's mission will not be over. Speeding at 3.0 to 3.3 AU a year, the spacecraft should reach a distance of over 100 AU from the Sun before the craft's signals grow too weak to hear.

Before attaining this distance, the spacecraft may enter the Kuiper belt, a region of the solar system that many scientists believe contains comets. First proposed by Gerard Kuiper in the 1950s, this comet belt may extend from just beyond Neptune's orbit to several hundred AU from the Sun. The Kuiper belt is distinct in two ways from the better known Oort cloud, which also contains comets. First, the Kuiper belt is much closer to the Sun than the Oort cloud is; second, the Kuiper belt is flattened, whereas the Oort cloud is spherical. As the Mariner spacecraft travels beyond Pluto, it may detect bodies in the Kuiper belt by feeling their gravitational pull. Also, the spacecraft will search for dust produced when objects in the Kuiper belt collide.

Mariner Neptune

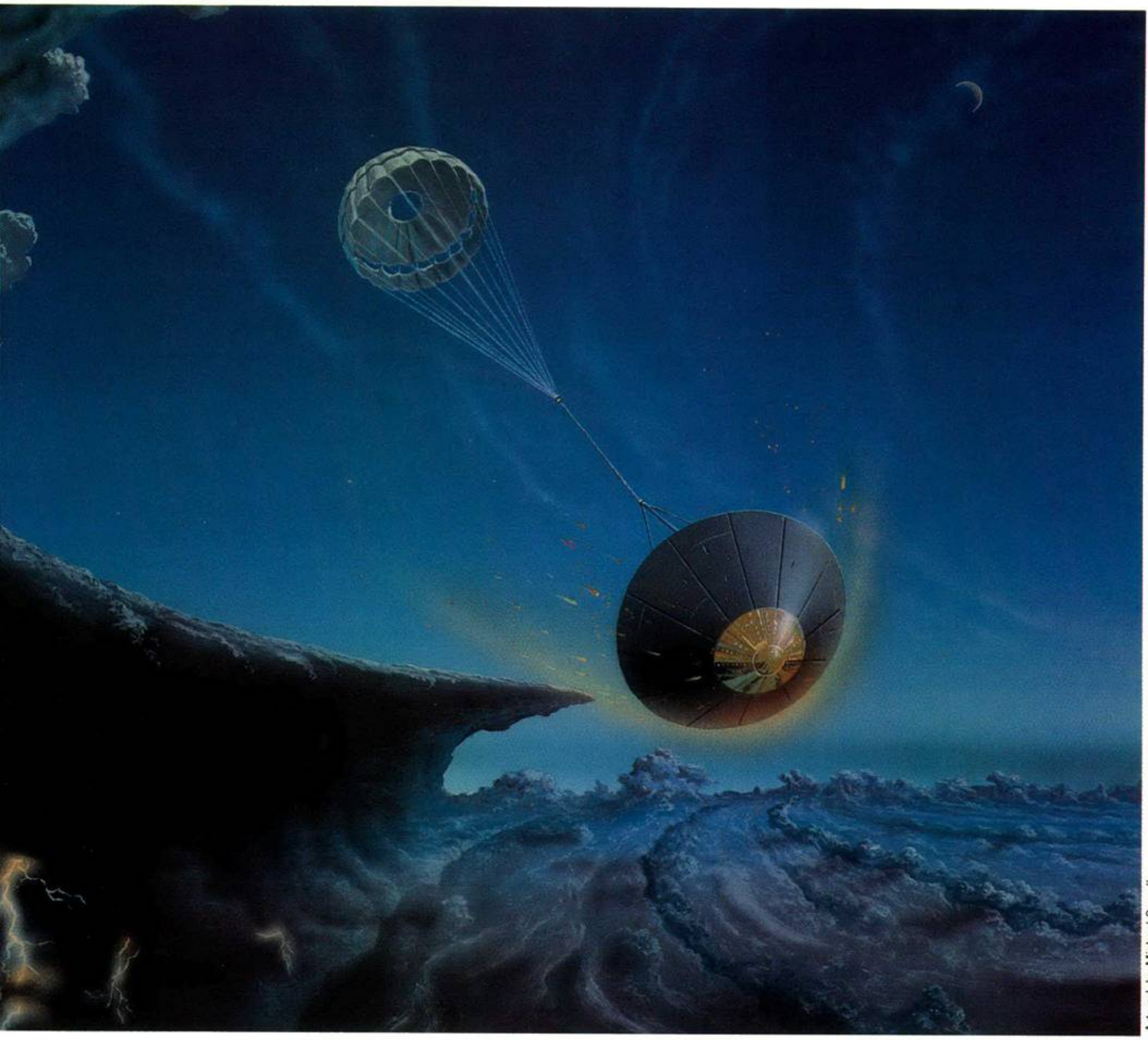
Long before then, though, the Neptune craft will be on its way. Launched in 2002, the Neptune mission will meet Venus in late 2002 and again in 2004, Earth in 2005, and Jupiter in 2007. Each flyby will alter the trajectory, and the final one, with Jupiter, will sling the craft to Neptune. Along the way, the spacecraft will examine Venus, Earth, a few asteroids, and the Jovian system.

The most exciting encounter, though, will occur several years after the Jupiter flyby. In 2010 or 2011, as the craft journeys between the orbits of Saturn and Uranus, it may encounter, from afar, the mysterious object Chiron. In 1977, when Charles Kowal discovered this 200-km-wide body, astronomers classified it an asteroid. Since then, however, the "asteroid" has developed a coma, a halo of gas and dust suggesting that Chiron is a gigantic comet (see "The Changing Face of Chiron" by William K. Hartmann, August 1990 issue). Mariner will probably pass over a hundred million km from Chiron, but even from that distance the spacecraft should tell us something. Scientists are presently studying how close Mariner can approach Chiron and still stay on course for Neptune.



DROPPING TOWARD OPAQUE CLOUDS, the Neptune probe descends into the Neptunian atmosphere, sampling what it finds until pressure crushes it and stops transmission.

Mariner will reach Neptune in 2021. One to three weeks prior to encounter, the spacecraft will send its probe on a mission into Neptune's thick atmosphere. The same day the Mariner spacecraft achieves orbit around Neptune, the probe will strike the top of Neptune's atmosphere. A heat shield will protect the probe from incineration. After jettisoning the heat shield, the probe will deploy a parachute to slow its descent. The probe will float through the clouds and get tossed about by the winds, all the while measuring the temperature, pressure, and composition of the atmosphere. When the probe reaches a pressure of about 15 bars (one bar is one Earth atmospheric pressure), it will cut off its parachute and plunge fast into the heart of Neptune. Down and down the probe will fall, investigating the depths of Neptune's atmosphere before the planet crushes it at a pressure of perhaps 75 to 100 bars.



Artwork by Michael Carroll

Even as its probe dies, the Mariner spacecraft will begin orbiting Neptune. The spacecraft will study the planet, its moons, and its rings for at least four years. Mariner's first orbit will be leisurely, taking 200 days. At its farthest from Neptune, the spacecraft will fire its rockets and reverse motion, so that the spacecraft's orbit around Neptune becomes retrograde, like Triton's. With a retrograde orbit, Mariner can study Triton better, because the spacecraft will then fly more slowly relative to Triton than it otherwise would. The first encounter with Triton will shrink the spacecraft's orbit and reduce the period from 200 days to 80 days.

As it circles Neptune, Mariner will continually observe the clouds and winds in the planet's atmosphere and probe Neptune's magnetic field. But Triton is the main attraction. Mariner will make 25 to 40 close approaches to the wayward moon, at times coming within a mere 500 km of the satellite's surface. Mariner will map most of Triton, whereas Voyager studied less than half the moon at high resolution. Furthermore, the best resolution should be 20 to 50 times better than Voyager's. The spacecraft will monitor Triton's atmosphere and geysers, seeing how they and the rest of Triton have changed in the 32 years since Voyager last checked on the satellite. Mariner will also study the other moons. Eccentric Nereid will receive a close visit, as will at least one other satellite, perhaps Proteus, the second largest. The spacecraft will conduct a search for new moons around Neptune and study the rings as well.

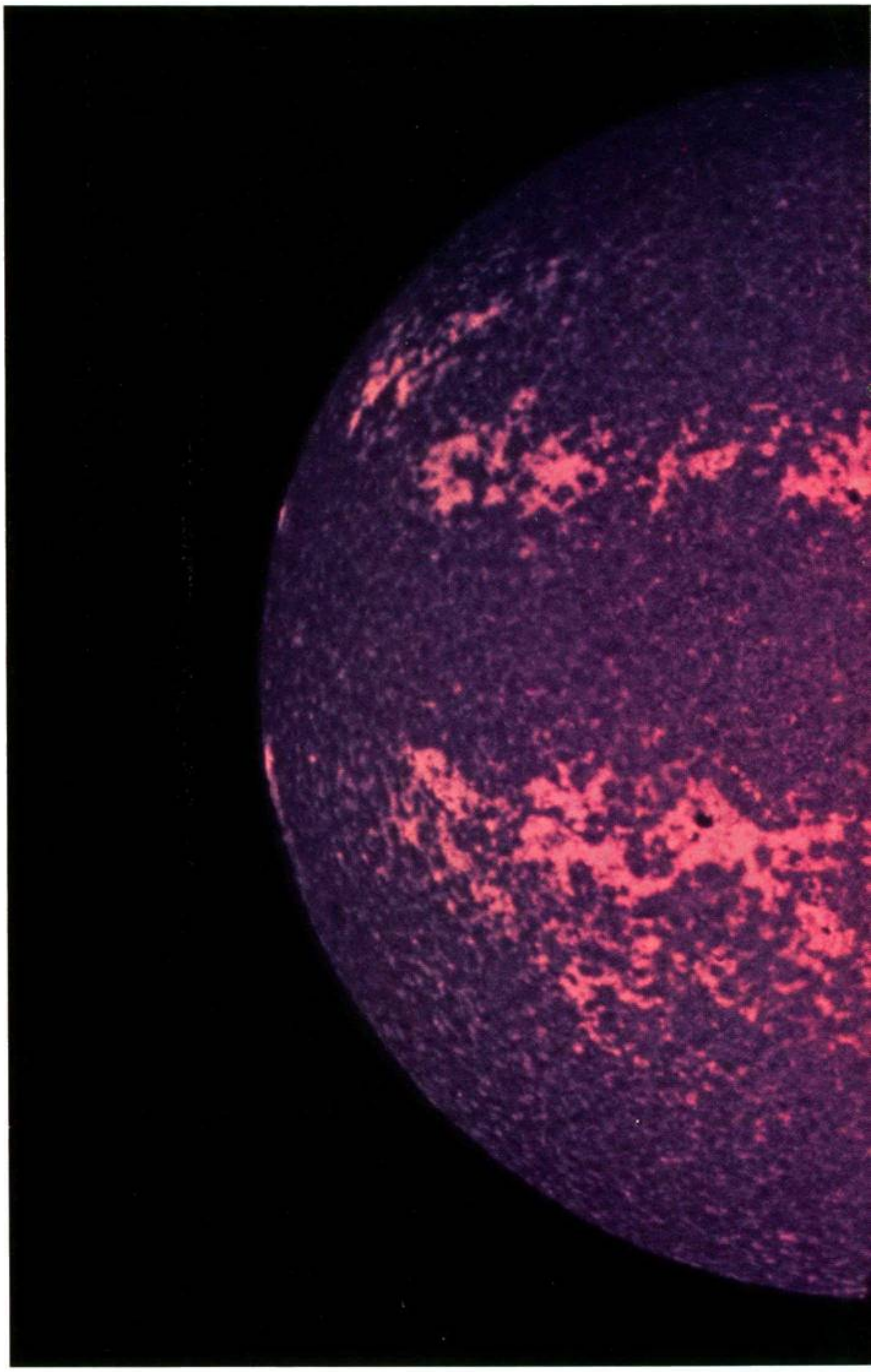
Both the Neptune mission and its Pluto counterpart promise a scientific return as enormous as the project itself is ambitious. Neptune, Triton, and Pluto are cold, remote worlds that huddle on the frigid frontier of the solar system, billions of miles distant. To investigate these far-off worlds thoroughly requires the daring and imagination that mark this country's spirit of adventure and exploration. ☐

Ken Croswell is an astronomer in Berkeley, California, and a frequent contributor to ASTRONOMY. He also writes for New Scientist, Science, *and* Star Date. *His last article for ASTRONOMY was "The Best Black Hole in the Galaxy" in the March 1992 issue.*

Unfolding Mysteries of Stellar Cycles

Observing rhythmic changes in stellar magnetic fields, astronomers study how these fields form in the deep interiors of solarlike stars.

by Sallie Baliunas and Steven Saar



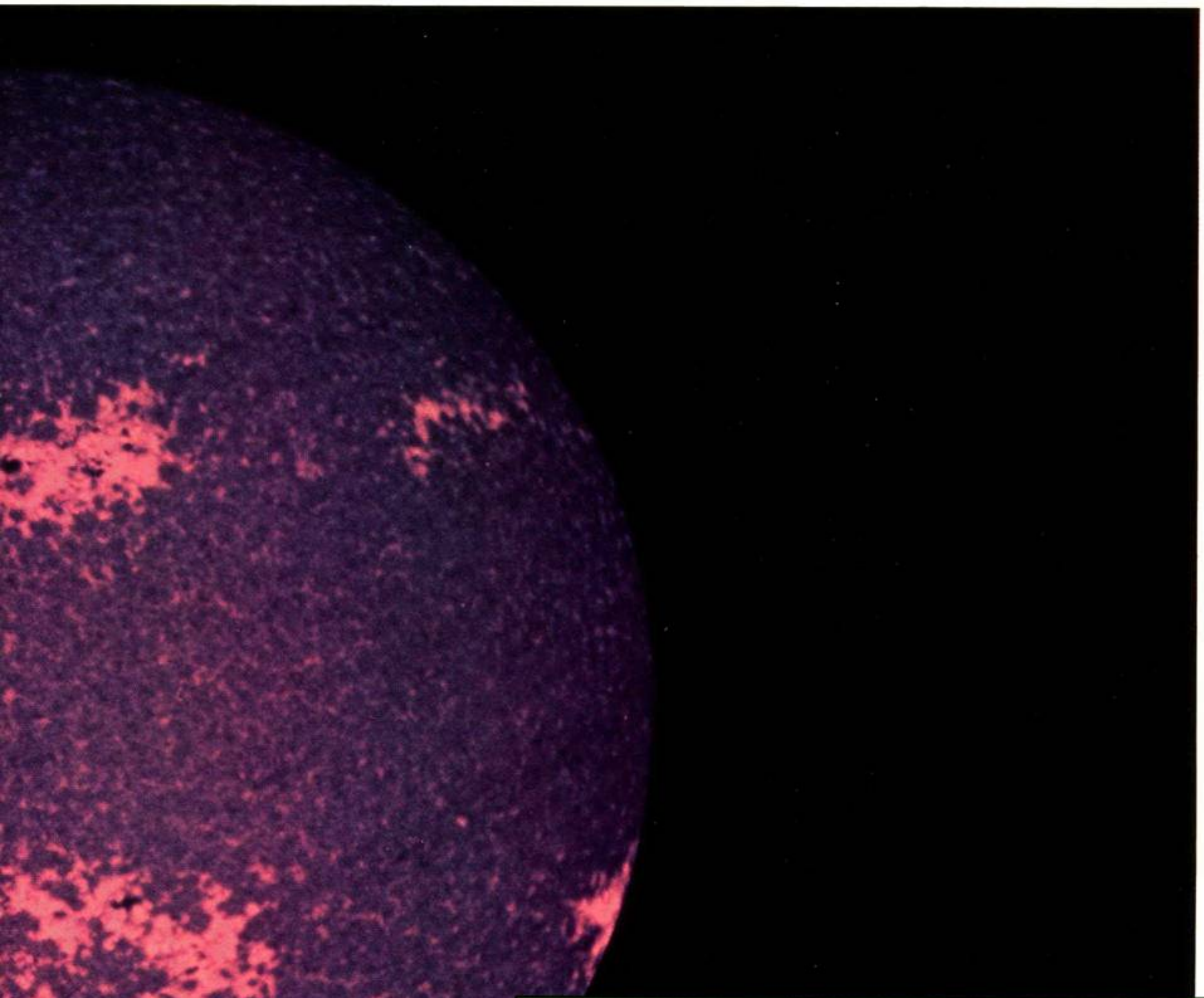
Dark spots and bright active regions mottle the surface of solarlike stars, giving evidence to their constantly changing magnetic fields. The best known case of stellar activity is the 11-year spot cycle of the Sun, but during the last 25 years astronomers have learned that most solarlike stars also generate magnetic fields that vary cyclically. In spite of the recent blossoming of knowledge about stellar magnetic activity, the mechanism that produces the fields remains one of the great puzzles of astrophysics. And to add to the mystery, recent observations show that the magnetic cycles sometimes appear to turn off.

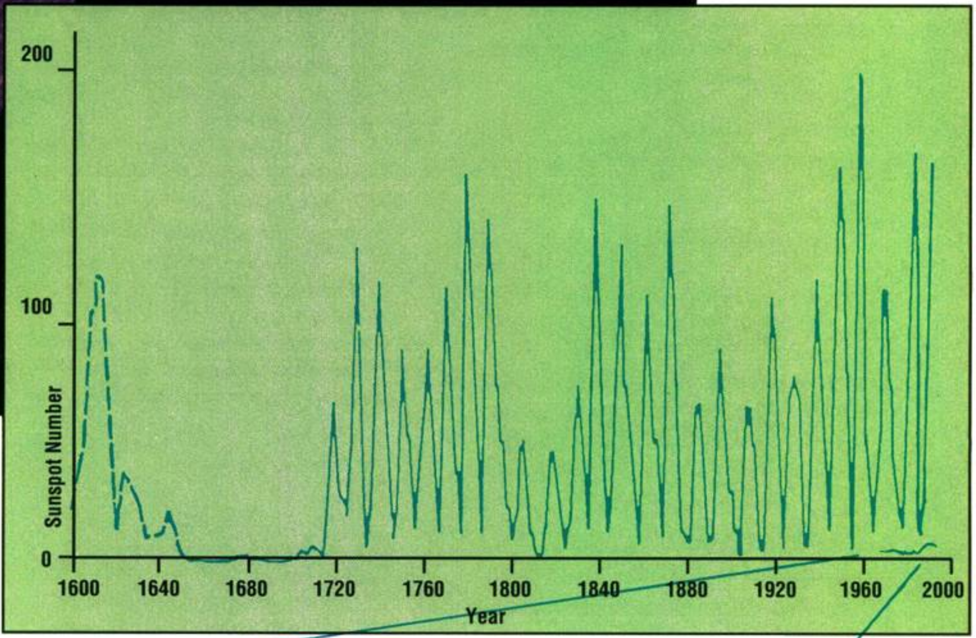
The first evidence for magnetic activity cycles in stars came in 1843 when Heinrich Schwabe, a German astronomer, discovered that sunspots vary in number over an 11-year period. Since then, astronomers have found that the spot cycle marks changes in the Sun's global magnetic field over a 22-year period. As the magnetic fields change polarities from north to south and back to north during the activity cycle, the spots peak in number twice.

The polarities of sunspots also follow the 22-year magnetic cycle. However, it is often more convenient to use spot numbers rather than magnetic polarity to track magnetic activity, especially when dealing with historical records. Early records of solar activity (starting around 1610) report only spot numbers. We will use the shorter spot cycle to describe the magnetic cycle.

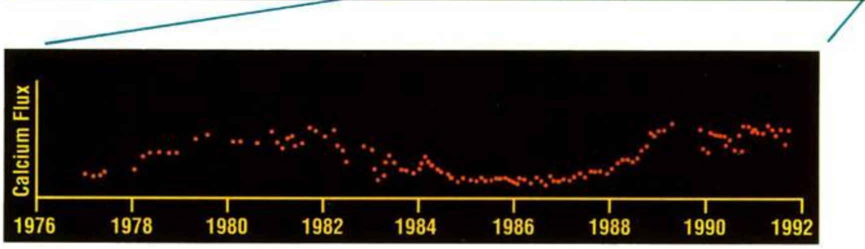
The spot cycle is somewhat irregular and mysterious. The cycle lengths aren't exactly 11 years, varying from 7.3 to 17.1 years. Nor are the cycles equal in amplitude. At solar maximum, the time of maximum spot activity, the number of spots varies from a low daily average of 49 spots to a high of over 200. And as first discovered by Walter Maunder, an English astronomer, and rediscovered in 1976 by Jack Eddy of the High Altitude Observatory, the Sun sometimes enters a prolonged period of low magnetic activity.

Early spot records show that the last dramatic episode of low activity started about 1645 and lasted for 70 years. Not only were there few spots, but the activity cycle itself seemed absent. This period of inactivity, dubbed the Maunder minimum, indicates that the solar cycle is even less regular than astronomers first thought. Pushing the study of spot activity back even further with indirect indicators of spot activity, like radioactive elements in tree rings

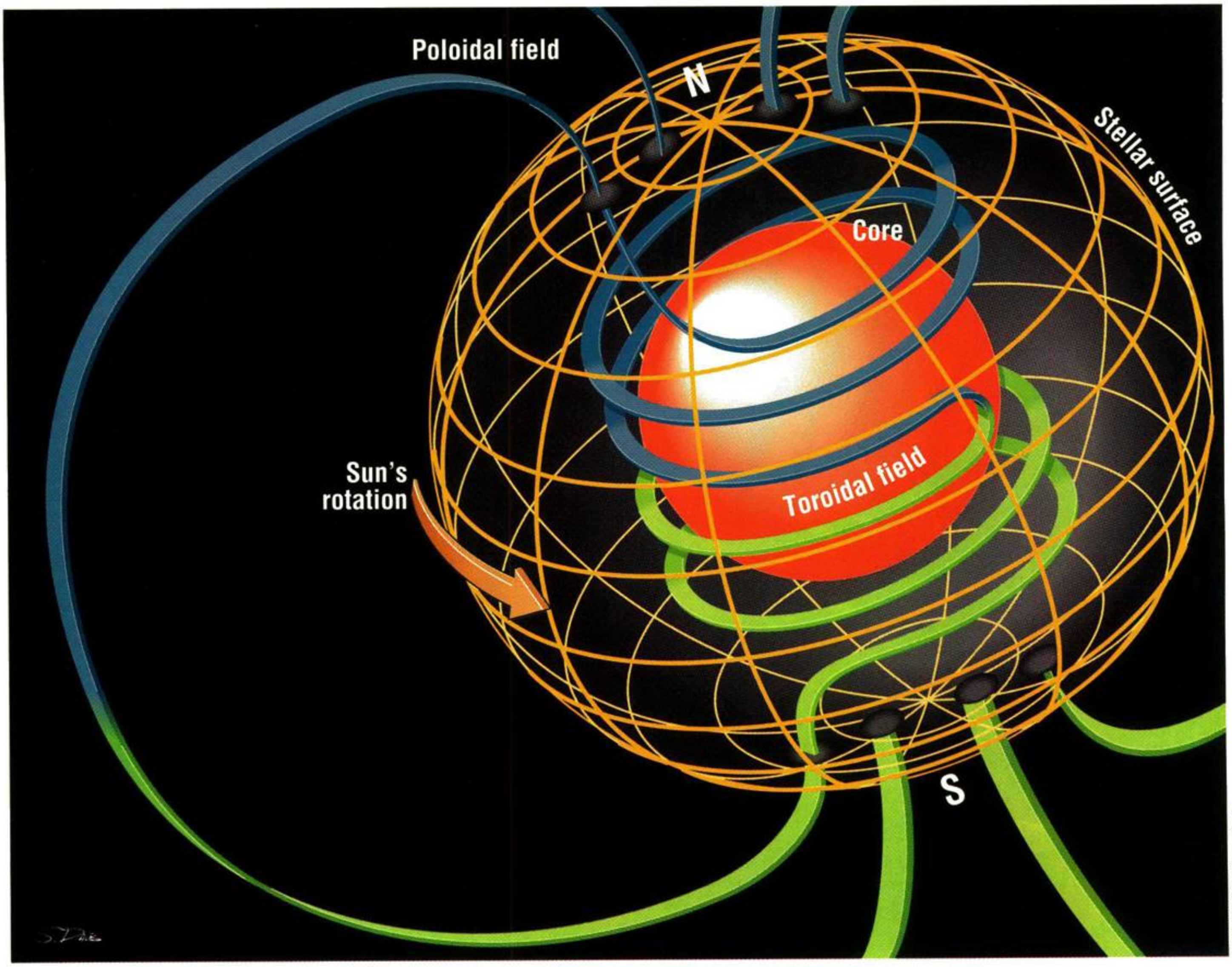




SOLAR ACTIVITY, such as spots and the active regions shown above in the violet light of calcium, varies with a period of 11 years. National Solar Observatory/ Sacramento Peak photo.



THE SUN'S CALCIUM BRIGHTNESS changes with the spot cycle. Astronomers use calcium brightness as a substitute for magnetic field measurements. Data provided by Steve Keil.



ASTRONOMY: Steve Davis

DYNAMO ACTION regenerates magnetic fields by transforming polar-oriented, or poloidal, fields into doughnut-shaped, or toroidal, fields — and vice versa — in the interior of stars like the Sun.

and glacial ice cores, suggests that the Sun spends about one-third of its time in such Maunder minima.

The study of how the Sun generates its magnetic fields started in 1908 at Mount Wilson Observatory when George Ellery Hale established the connection between sunspots and magnetic fields. About 50 years later at Mount Wilson, Harold and Horace Babcock (father and son) discovered the much weaker general field of the Sun. Both Hale and the Babcocks used the Zeeman effect to measure the magnetic field. The presence of a magnetic field causes a spectral line to split into several components. The separation of the Zeeman components is an indication of the magnetic field strength.

Once magnetic fields could be measured directly and not just inferred from the number of spots, astronomers realized that the Sun's general field varied over a 22-year period. This realization led to the first theory of how surface magnetic fields are created. Because a magnetic field left over from the time when the Sun formed would have long since died away, some mechanism must continually regenerate the magnetic fields. Researchers call this mechanism a dynamo.

Solar dynamo models start with a poloidal field (like the dipole field of a bar magnet or the Earth's magnetic field). The Sun's rotation, which is faster at the equator than at the poles, slowly winds the field into a toroidal, or doughnut-shaped, field in the Sun's interior. Convection — the rising of warm gas as cooler gas sinks — transports some of this magnetic field from the interior to the surface to create spots. As the original poloidal field dies away, the toroidal fields regenerate the poloidal fields, but now of opposite polarity. Repeating these steps returns the polar fields to their original polarity, thus completing the magnetic cycle.

While dynamo models predict the general characteristics of the Sun's activity cycle, they fall short of the mark when it comes to predicting the details of the cycle. For example, one dynamo model predicts that the length of the cycle is only one year and that spots migrate from the equator to the poles instead of the other way around as occurs on the Sun.

Helioseismology, the study of the Sun's oscillations to explore its interior, might one day provide some insight into how the convection zone works and thus help improve dynamo models. But there is another way to explore how magnetic fields generate and that is by looking at activity cycles on other stars. Studying a larger range of activity will give us more insight into the production and characteristics of magnetic fields than studying the Sun alone ever could. And other stars can provide a glimpse of the past and future history of the Sun's activity cycle.

Stellar Magnetism

Unlike the Sun, no solarlike stars show Zeeman splitting of lines in the optical portion of their spectra. Only a few of the stars, such as AD Leonis, have measurements of Zeeman splitting in the infrared, where the splitting is larger. The splitting of optical lines in these stars isn't strong enough to produce widely separated Zeeman components, so the spectral line appears slightly broader than normal instead. Researchers observe Zeeman-broadened lines in a number of solarlike stars. In fact, the observational method has progressed sufficiently that astronomers now map surface magnetic fields on stars such as HD 82558 (see AstroNews, February 1992).

Unfortunately, stellar Zeeman splitting and broadening measurements take a lot of time and can be taken only for brighter stars. To understand stellar activity cycles, we need to observe the magnetic activity of a large number of stars. Because measuring the magnetic field directly isn't feasible and spots remain uncountable on the surfaces of the pointlike stars, we need a magnetic field substitute, or proxy, that is easy to measure, even for faint stars.

Spots are only one form of magnetic activity. Although they are the most easily recognized feature on the Sun's surface, spots are small and short-lived compared to the entire active region in which the spot forms. The more common form of magnetic activity is bright plage. For solarlike stars, Zeeman splitting and broadening measurements typically determine the area and strength of the magnetic fields not in spots, but in extended plage regions.

A plage appears particularly bright in the light of individual spectral lines like the red hydrogen-alpha and violet calcium H and K lines. When a star is near the peak of its activity cycle, it has more plage regions. More plage regions means more calcium emission, so the star's increasing calcium brightness, or flux, tracks the increased activity of the star's magnetic cycle. Thus calcium flux makes a good proxy for magnetic field measurements.

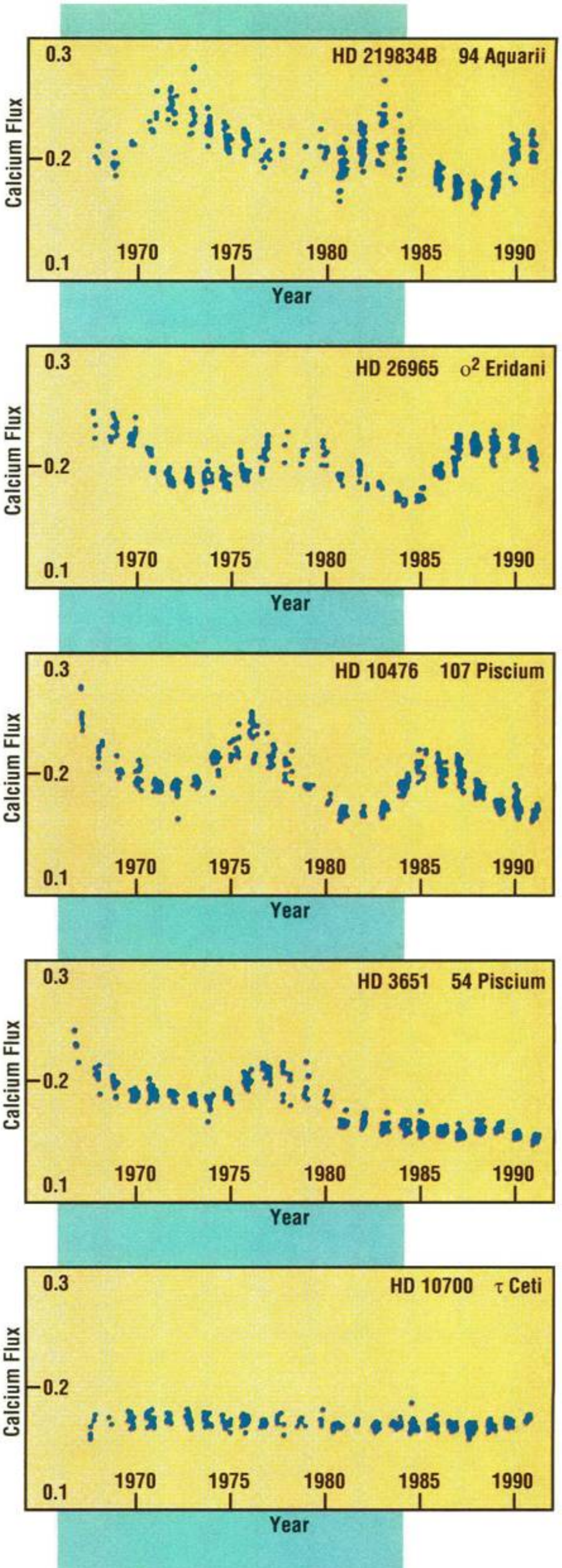
The first calcium-flux study of stellar activity was started in 1966 by Olin Wilson, who used the 100-inch telescope at Mount Wilson Observatory. Wilson observed 91 stars over 11 years (over 12,000 observations!) and found that about one-quarter of the stars showed solarlike activity cycles. Most of the rest of the stars varied also, but not in an apparently repetitive way.

Wilson's survey has continued at the 60-inch telescope at Mount Wilson since 1977. Although we now have 25 years of data (including Wilson's observations), the long time-scale of stellar activity requires decades of data to determine the period of the activity cycle. So we hope to continue this program for at least another 25 years to shed light on stars whose cycles have long periods. About 300 main sequence and giant stars are included in the new observing program. The stars range in spectral type from F through K and include stars with ages from roughly one billion to ten billion years. Our observations show that two-thirds of the stars show cyclic behavior, while the remaining stars show erratic or little variability.

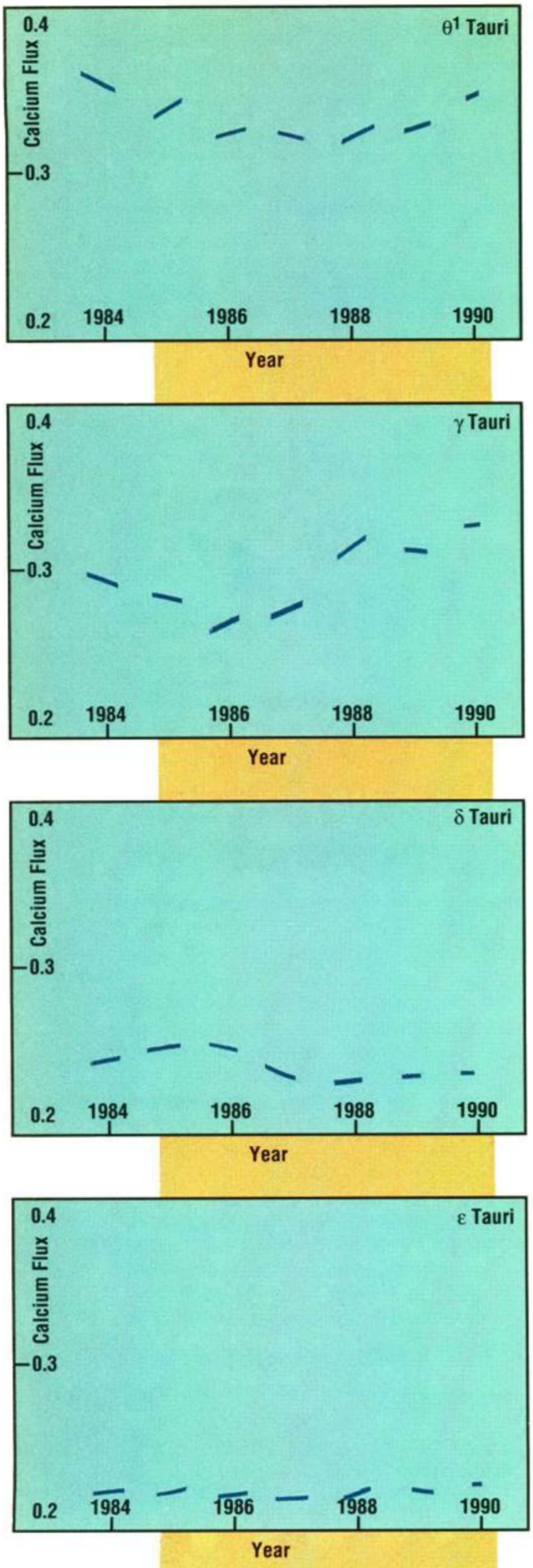
Stellar Cycles

The first thing that one notices when looking at stellar calcium flux measurements is that some stars have large average flux and others have low average flux. Therefore, we break stars into two groups, active (strong calcium emission) and inactive (weak calcium emission). In this system, the Sun is considered an inactive star. The figures on this page show the calcium flux for five stars plotted versus time. The amount of variability is not important in deciding whether a star is active or inactive, only the average level of calcium flux.

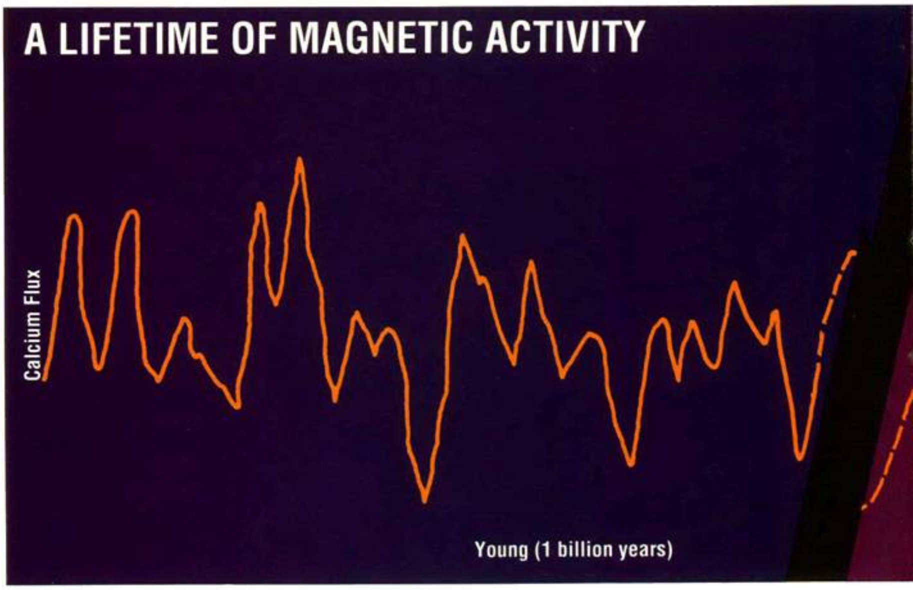
Because plage regions are slightly brighter than the surrounding stellar atmosphere at all wavelengths and not just in the light of hydrogen and calcium, the visible brightness of a star changes with magnetic activity. Charles Abbott of the Smithsonian Institution first reported such brightness changes for the Sun around the turn of the century, but variations in Earth's atmosphere made such measurements suspect. However, recent spacecraft confirmed Abbott's report that the Sun does change in brightness by up to 0.1 percent.



LARGE CALCIUM FLUX that varies with time typifies active stars (top three graphs). Low, nearly constant calcium flux characterizes inactive stars (bottom two graphs).



CALCIUM FLUX EMISSION appears vastly different in these Hyades giants even though the stars have the same spectral type and age. The inability to observe year-round causes the data gaps.



At first astronomers thought that a star's visible brightness should decrease owing to the increased number of dark sunspots. But because of the larger area of the plage regions and their longer lifetime, an increase in the star's brightness accompanies an increase in stellar magnetic activity. Richard Radick of the Air Force Phillips Laboratory, Wes Lockwood of Lowell Obser-vatory, and one of us (SB) have recently observed such increases in stellar brightness at times of higher stellar activity as indicated by increased calcium emission.

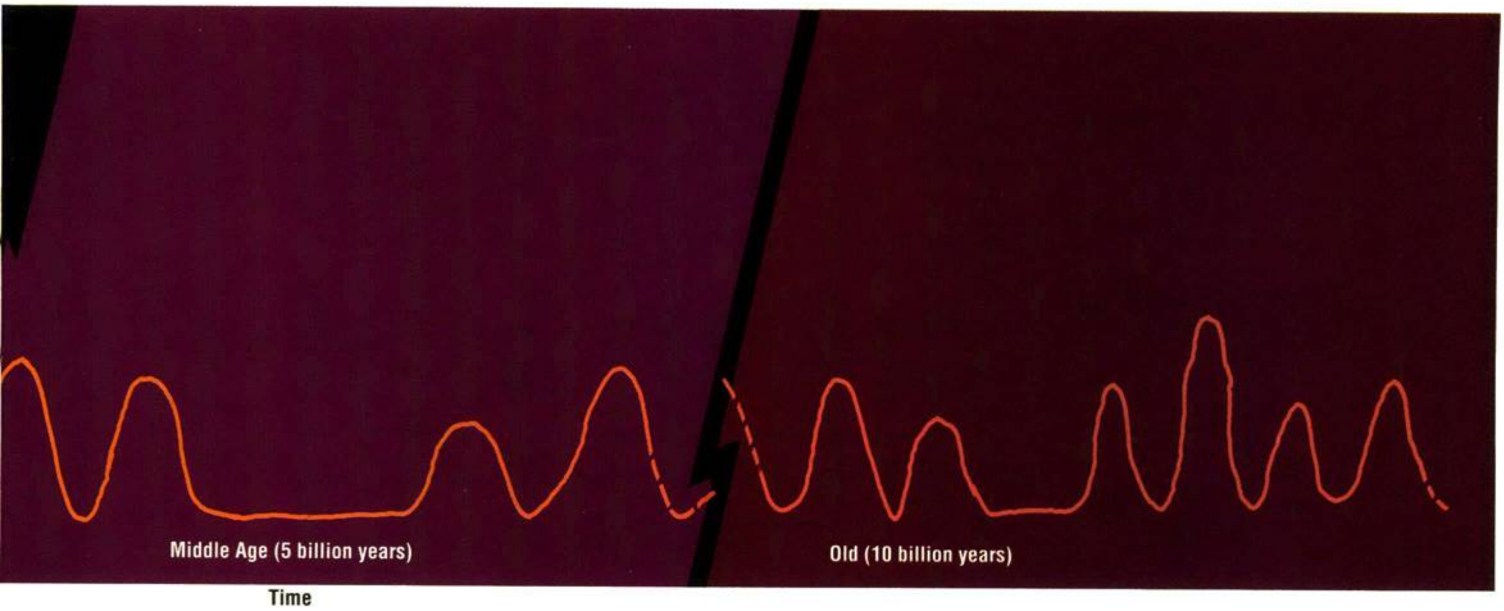
Young stars, however, show the opposite relation between visible brightness and calcium flux compared with the middle-aged stars described above. These stars become fainter as their calcium flux increases. Large spots apparently dominate the magnetic field regions of these stars rather than plage. As a star's calcium flux increases, signaling the presence of a magnetic region, its visible brightness decreases, owing to the large, dark spots.

Certainly variations in a star's brightness are interesting in their own regard. But they also imply that the Sun's brightness may be highly variable. Solar brightness variations may have a profound effect on Earth's atmosphere. The small changes in the Sun's brightness over the 11-year spot cycle are unlikely to cause long-term climate variations. However, there are some suggestions that larger variations are likely. For example, brightness changes of solarlike stars can be as large as 0.5 percent. Such a large change in the Sun's brightness might account for the temperature variations during the late 1600s. The drop in the mean global temperature of roughly one degree brought harsh winters and ice to the North Sea, leading to the description of this era as the "Little Ice Age." A better understanding of the solar cycle would improve our ability to predict such dramatic effects on our climate.

In addition to having a low calcium flux, inactive stars tend to show little flux variation. Astronomers originally believed the low activity indicated that these stars were old, with weakened dynamo mechanisms. Some of our recent observations show that these stars are in a state of Maunder minimum. One such star is HD 3651, which appears to be caught in the act of entering a Maunder minimum, going from active to inactive (see the graph on page 45).

The existence of stellar Maunder minima leads to several important conclusions. The level of calcium flux is not a precise indicator of a star's age. Secondly, the number of stars in flat, Maunder minimum states confirms the idea that middle-aged stars spend about one-third of their time in minimum states. Third, magnetic activity is less during a Maunder minimum state than during a spot cycle minimum.

Astronomers first thought that magnetic activity during sunspot minima and during Maunder minima is the same because the number of spots is nearly zero during both minima. But our stellar observations show that activity is actually much *lower during Maunder minima*. This lower magnetic activity means that the star's calcium flux and visible



A STAR'S MAGNETIC LIFE HISTORY starts with high activity and short, erratic cycles. Middle-aged and old stars have lower activity and periodic cycles. Middle-aged stars spend about one-third of their time in Maunder minima.

brightness is lower. If the normal brightness variation during the sunspot cycle is about 0.1 percent, then the brightness of the Sun at the time of its last Maunder minimum could have been up to one percent lower than the present Sun, enough to explain the Little Ice Age, according to climate models.

Variability in young stars is erratic rather than cyclic as it is in the Sun. These stars may have several short periods that interact with each other to give an erratic appearance to their calcium flux output. Or the presence of strong flares and long-lived active regions may confuse the calcium flux signal.

Older stars show cyclic variations with periods ranging from 2.6 years to longer than 25 years. The periods do not depend in any obvious way on the mass, age, magnetic activity level, or rotation period of the star. Nor do any simple combinations of these stellar parameters predict the period. But recently we have found a relation between the period and parameters that describe the characteristics of the star's dynamo. While more observations and further analysis of this relation are needed, we now have another tool with which to test dynamo theories and explore how magnetic fields are generated in stars.

Magnetic activity isn't confined to main sequence stars. Giants in the Hyades star cluster (see the graphs on the opposite page) show calcium flux behavior like that of the main sequence stars. About one-fourth of the giants are in a flat, minimum state and the active giants show a range of periods and activity levels. Astronomers suspected that giants wouldn't show activity cycles, because these stars evolved from A-type main sequence stars, which lack solarlike magnetic activity. The giants apparently have activity cycles because convection in the interiors of these stars now drives a dynamo. The slow rotation of the stars and the high level of activity permit the exploration of an entirely different set of dynamo characteristics as researchers struggle to learn about magnetic field production.

Life History of a Star's Activity

Stellar observations give insight into the history of a typical star's magnetic activity. The observations hint at what the Sun's activity was like 3 or 4 billion years ago, and what it may be like 5 billion years from now.

At an age of about one billion years, a star rotates once every 9 days or so. This young star has an average calcium flux level about twice that of the present-day Sun. Its calcium flux is highly variable but the variability probably shifts between erratic behavior during periods of intense magnetic activity — like solar flares — and a periodic cycle perhaps as short as 2.5 years. When the calcium flux increases, the visible brightness of the star generally decreases by several percent, owing to the appearance of large, dark starspots.

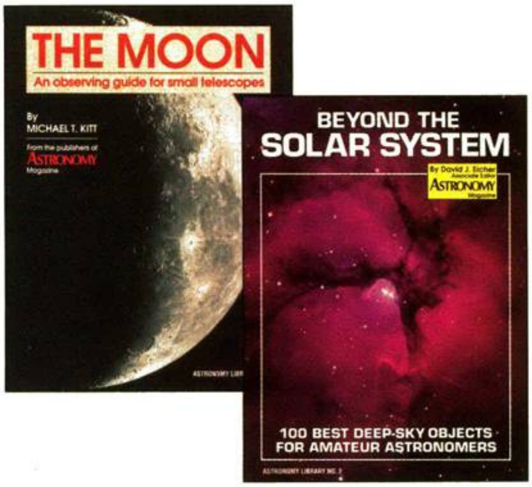
Middle-aged stars, about 5 billion years old, behave much like the Sun. The average rotation period is about 27 days and the average calcium flux level is like that of the Sun. The star's brightness changes in concert with the calcium flux level because bright plage dominates the magnetic regions. During the periodic starspot cycle, the star is near minimum about one-fourth of the time. And the star enters a Maunder minimum of low magnetic activity about one-third of the time.

Old stars still behave much like their middle-aged cousins. The rotation periods are slightly slower but the average calcium flux levels remain about the same. The period and amplitude of the activity cycle also stay about the same. And as the star enters the giant phase, the cycle will probably continue.

Despite this insight into the behavior of a star's magnetic cycle across the ages, astronomers still know little about how the fields form. Stellar dynamos remain one of the great mysteries of astrophysics. Although the active-inactive star dichotomy is now understood, why stars enter states of Maunder minimum isn't clear. And why stellar cycles don't change more dramatically as stars age and their convection zones evolve remains a puzzle. Perhaps the next 25 years of observing will prove as fruitful as the first 25 as we further explore stellar activity cycles. ☐

Sallie Baliunas and Steven Saar are astronomers at the Harvard-Smithsonian Center for Astrophysics. Sallie Baliunas is also deputy director of the Mount Wilson Institute.

ASTRONOMY SKYMART



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LIFE AROUND A LARGER SUN

If Earth orbited a star 50 percent more massive than our existing Sun, would our world be livable?

by Neil F. Comins

Earth lies at the perfect distance from a beautiful star. The Sun provides just enough heat so that water can exist here in any of its three states: solid, liquid, and gas. In its liquid state, water is a universal solvent and is thought to have been critical to the origin of life. Would our planet, located at the same distance from a different-sized star, be as suitable a home for the origin and evolution of life? What if, that is, our Sun were more massive than it actually is?

Mass is the fundamental measure of how much material something contains. It is not the same as weight. An object's weight depends on how far it is from the center of Earth (or any other astronomical body it sits on). The farther the object is from the center of Earth, the less it weighs. Mass, on the other hand, is intrinsic to an object — an object has the same mass whether it is sitting on Earth or free-falling through space.

For our speculation, we're going to assume our new Sun is fifty percent more massive than the real Sun. A star that contains 1 1/2 solar masses is not exceptionally massive. The highest-mass stars astronomers have observed possess somewhere between 60 and 120 solar masses, while the lowest have just under 1/10 solar mass.

Reaching Peak Intensity

To understand our hypothetical Sun's effect on Earth (and the solar system, in general), we need to look at two factors: gravity and radiation. First, the Sun's mass creates the gravity that controls the movements of the planets, asteroids, and comets. Second, the Sun emits energy in the form of electromagnetic radiation and high-speed particles that bombard Earth and provide the energy necessary for life to thrive here.

Our new Sun has different amounts of both gravity and radiated energy. We'll examine the effects of each, but so we understand the point we're starting from, let's check what the real Sun is like. Its most critical characteristic is its surface temperature — 5800 kelvins. That makes the Sun a yellow star. But why yellow?

You probably know intuitively that the temperature of a hot object determines its color. For example, as a piece of metal in a fire heats up, it changes color from its room-temperature gray to red to orange to yellow to blue-white and eventually to white. Similarly, the hotter a star is, the whiter it appears; the cooler it is, the redder it appears.

But looks can be deceiving. Stars (and the heated piece of metal) actually give off all colors, as well as all other forms of electromagnetic radiation, including infrared, radio waves, ultraviolet radiation, X rays, and gamma rays. This is called the electromagnetic spectrum, of which the rainbow or visible spectrum represents a tiny piece. All this radiation travels as waves differing only in their wavelength or distance from one wave crest to the next.

If objects emit a range of wavelengths, why does each hot object appear to have a certain color? The answer is that hot objects don't emit equal intensities of all wavelengths. Each object has a peak in its electromagnetic spectrum — light is emitted more strongly at one color than at the others.

More to the point for our story, different temperatures always correspond to different colors. As the temperature increases, the wavelength of the peak shifts towards shorter wavelengths, a relationship called Wien's displacement law, after German physicist Wilhelm Wien, who discovered the principle in 1893.

Room-temperature objects have their radiation peak in the infrared. To our eyes, insensitive to infrared light, these cool objects just look their normal color (from reflected light). Heating an object will make it first glow red hot since red has the longest visible wavelength. When an object is heated further its peak moves through the visible spectrum toward violet, since violet has the shortest wavelength. Heated beyond that, the peak is in the invisible ultraviolet. In the visible part of the spectrum, the object emits nearly equal amounts of energy at each color and so appears white.

Our eyes are sensitive to only a small range of the complete electromagnetic spectrum. Human eyes evolved to see the tiny part of the spectrum where the Sun shines most brightly — visible light. In fact, our eyes are most sensitive to yellow-green light, corresponding to the color of the Sun from its surface temperature of 5800 kelvins.

Indirectly, however, we do see other colors emitted by the Sun. The blue of the sky is blue sunlight scattered by atoms and molecules in our atmosphere. The orange and red of a sunrise or sunset appear when all the other colors are filtered out by the extra layers of atmosphere the sunlight must pass through when the Sun is low in the sky.

The fact that our eyes adapted to the brightest radiation emitted by the Sun is not a coincidence. The gases in our atmosphere absorb or reflect much of the electromagnetic radiation from the Sun, but virtually all of the visible light emitted by the Sun in our direction reaches Earth's surface unscathed. On the other hand most of the ultraviolet radiation and all of the X rays and gamma rays from the Sun are blocked by our atmosphere. Some of the heat, or infrared radiation, from the Sun, vital for keeping surface water liquid, is actually reflected back into space or absorbed by water vapor in our atmosphere. Happily, enough infrared radiation is trapped by the atmosphere to make the surface comfortably warm.

So our eyes adapted to the peak in the Sun's radiation in part because it is so bright, and in part because that bright light reaches the ground and reflects well off most objects. Visible light is therefore useful in providing our brains with information about distant objects. If the Sun's brightness peak had been somewhere else in the spectrum or if the visible light from the Sun didn't get through our atmosphere to Earth's surface, then the range of electromagnetic radiation we see would be different.

Bright and Blue

Now for the new Sun. Our new Sun's surface temperature is about 7000 kelvins. We would classify it as a type F star. It gives off five times as much energy per second as our present Sun and is 30 percent larger in diameter than our Sun. Although it gives off all types of radiation (like our Sun), its higher surface temperature makes it appear more blue. A brighter, bluer Sun means more blue light to scatter off our atmosphere, and therefore a sky that's even more vividly blue. That's the first, and least obtrusive, consequence of our "what if" scenario.

For the purposes of the scenario, we'll place Earth at the same distance from this new Sun as from the old. Under these circumstances, the new Sun appears 30 percent larger in the sky. Not only is the Sun more impressive, so are the sunsets. The colorful displays are longer and more glorious. We can revel in an extended

period of green twilight, followed by brighter glows of yellow, orange, and red.

Our year is also noticeably shorter. The law of gravitation, in the form of Kepler's third law, tells us that the period of our orbit around the more massive Sun (our "new" year) will be only 82 percent as long as the current year, or 298 "old" days long. A 30-year-old person today, having lived the same length of time on Earth in orbit around the new Sun, would be 36½ "new" years old.

Life in the Radiation Zone

The gravitational effects of our new Sun are not nearly as dramatic as the effects of its increased radiation. For example, this Sun's light is five times more intense than that of our old Sun. That's strong enough to destroy our present eyes. Nature has almost certainly evolved very different eye structures in order for them to function under the glare of the blue-white star. Perhaps the eyes on the creatures of our transformed Earth are more heavily lidded and covered with built-in natural sunglasses.

Brighter light means that fish can live deeper in the ocean and still have enough light to see by. Photosynthesis can occur at greater depths. With a larger volume of water suitable for life, the oceans are more heavily populated, both by animals and by plants.

For habitats on the land, the most important change affecting the survival, evolution, and distribution of life is the higher level of non-visible radiation life is subjected to. Ultraviolet light and the higher-energy X rays and gamma rays are thousands of times more intense. This bath of ionizing radiation overwhelms our atmosphere's defenses. The new Earth's ozone layer is of little help blocking the incoming energy. Deadly radiation penetrates to the surface and inflicts severe damage to unprotected biological tissue. (Ionizing radiation has enough energy to separate the atoms in molecules, thus destroying the structure of living material. That's why exposure to too much X-ray radiation causes cancer and other diseases.)

The presence of intense levels of ionizing radiation at Earth's surface requires significant adaptations if life is to survive and flourish in this hostile environment. Is this an insurmountable problem? Probably not, considering the range of adverse conditions under which life thrives on our real Earth — boiling geysers, deep-sea thermal vents, Arctic seas. Life is everywhere.

So let's say that early in the history of our "what if" Earth, life forms in the shallows of oceans developed thick, metal-impregnated skins that effectively screened out dangerous radiation. Carrying this adaptation onto the land, life evolved with protective metallic shells or skins. Being heavy, some of these armored creatures evolved stronger muscles. Others just moved slowly.

Our speculation assumes that the new Sun could cause an environmental disaster. But there is another possibility. It's entirely conceivable that the higher level of radiation has itself changed the atmospheric chemistry sufficiently for the atmosphere to set up new screens to protect the surface from the radiation. Perhaps under a massive Sun, Earth would not be so unlivable after all. Except for the heat.

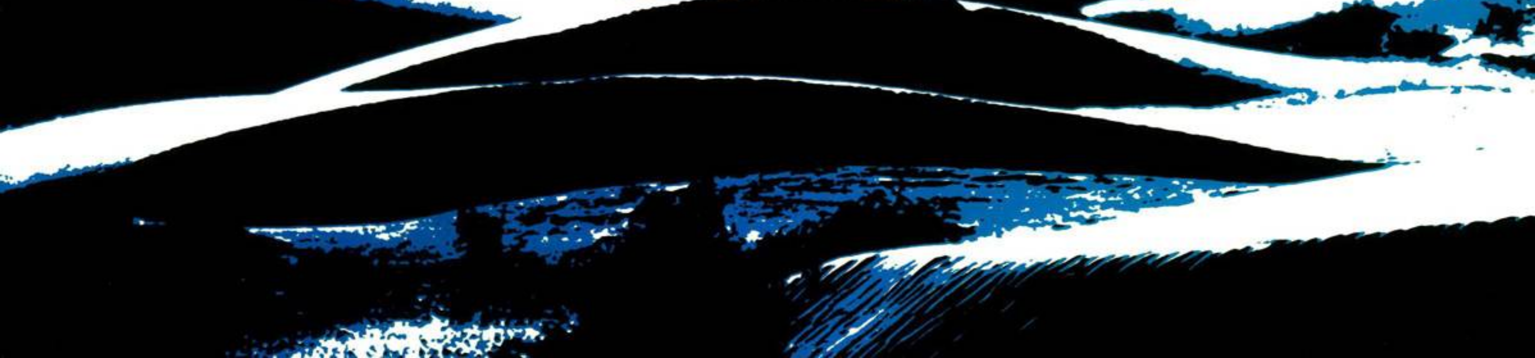
It's So Hot . . . !

Allowing for the fact that not all the heat from the Sun striking our atmosphere reaches Earth's surface, it turns out that the new surface temperature of Earth is typically 150° Fahrenheit instead of the 75° we normally enjoy today.

Needless to say, polar ice caps do not exist. The additional water has raised the shoreline, decreasing the habitable surface area of the planet. Much of eastern and central North America is under water and most of Earth's vegetation has adapted to tropical conditions. The heat also causes more evaporation of water into the atmosphere, resulting in a higher humidity worldwide. The humidity is so high that the planet has more or less continual rain. Under these conditions, heat becomes trapped between the surface and clouds, sending the temperature even higher.

Where could we, or our metal-shielded equivalents, comfortably live on this altered world? The

The new Earth's ozone layer is of little help blocking the deadly radiation.



fundamental issue is one of thermodynamics. Our internal temperature is 98.6° Fahrenheit, typical of warm-blooded animals. On our normal world, internal temperatures much above that eventually lead to death, and in hot climates it's important for all creatures to find ways to cool off. Our primary cooling mechanism is sweating — water in our bodies carries heat to our skin where it radiates away when the water evaporates. If the air temperature is high enough, however, heat begins flowing in through our skin instead of out. At internal temperatures above 102° F, brain damage occurs, and above 106° F death is likely.

On the new Earth, we'll assume animals have the same internal biology as we know today. If that is the case, the tropics are so hot at 150° F as to be uninhabitable by us and most other creatures that we are familiar with. The areas we call temperate zones are only marginally tolerable to life. With a 1$^1/_2$-solar mass Sun in the sky, Antarctica, northern Siberia, and northern Canada are now the most comfortable places to live. Although there is seasonal ice in Antarctica, in general the areas we previously considered to be frozen wastelands are now temperate and are the most desirable habitats in our new world for warm-blooded creatures. Separated by an uncrossable zone at the tropics, the polar regions evolve into two unique regions, each with their own indigenous life forms that never meet.

Or would they? Let's go one step farther. Let's call upon nature's marvelous ability to find adaptations for extreme climates. In this scenario, animals evolve to fill the niches in the hotter, equatorial climes. They maintain higher internal equilibrium temperatures, high enough that even at 150° F it is cooler outside their bodies than inside. Or if there are biological restrictions that keep internal temperatures below this level, then our hypothetical creatures might possess more efficient, built-in air conditioners than we and most other animals have. Perhaps the "what if" animals have large reservoirs of water they use to carry heat out, or they evolved with a biologically generated, freonlike refrigeration system similar to that used in mechanical cooling systems today.

How long it would take refrigerated creatures to evolve is anyone's guess. Evolution under a massive star might proceed at the same pace as on the real Earth, or the intense radiation could produce more genetic mutations, accelerating evolution. On the other hand, considering the special adaptations needed for survival on a hot Earth, sentient life could take millions of years longer to evolve than on our temperate Earth.

With a 1$^1/_2$-solar mass Sun in the sky, Antarctica, northern Siberia, and northern Canada are now the most comfortable places to live.

Making the Move

When considering whether life could exist around a 1$^1/_2$-solar mass star, an obvious solution to the overdose of heat and radiation is to allow the speculative Earth to exist farther away from the Sun. At a distance between the present orbits of Mars and Jupiter, we would encounter essentially the same amount of heat from the massive Sun as we receive here on Earth today. In other words, the present asteroid belt would be the center of the new Sun's life zone, the distance from a star where water can coexist in its three states. But as inviting as it sounds to live farther away, there is a catch, one that concerns the evolution of this star.

Stars and planetary systems begin their lives as clouds of gas and dust that collapse or condense because of their own gravity. Newly formed stars begin giving off energy that is created in their centers or cores. This energy, created by the fusion of smaller atoms into larger ones, comes to the stars' surfaces and then flies into space as the radiation we encountered earlier. It takes about a million years for the energy created in the core of our real Sun to reach its surface. Sunlight, traveling for eight minutes to reach us from the Sun's surface, was actually created a million years ago in its core.

But the energy-producing fusion process at the core will last only so long. Eventually the core's hydrogen fuel becomes converted into helium. Fusion stops. Lacking the outward pressure created by fusion and succumbing to the inward pressure of the mass of the star, the core begins to contract.

As the core contracts, the Sun's internal temperature goes up. This triggers previously unburned

hydrogen in a shell around the collapsing core to fuse into helium. The energy created in this shell pushes the outer layers farther out than they are now. In the case of our real Sun, its outer layer will expand outward and come to rest close to Venus' present orbit. The Sun will turn into a red giant and Earth will be fried to a crisp. Don't unload your real estate, though. This won't happen for another 5 billion years.

The helium cores in the Sun and in more massive stars compress until the pressure is high enough to fuse the helium into carbon. At this point, the core stops contracting. After their cores are converted to carbon, virtually every star with one solar mass or more ends its life cycle by ridding itself of material, either through a single massive explosion (for stars bigger than eight solar masses) or through a series of gentler pulses that blow off the outer layers of the star. Astronomers estimate that 5 to 8 billion years from now (roughly 10 to 13 billion years after it first formed) our Sun will shed its outer layers, forming a shell of expanding gases around it called a planetary nebula. The naked central core of the Sun will remain — a white dwarf star at the heart of the nebula.

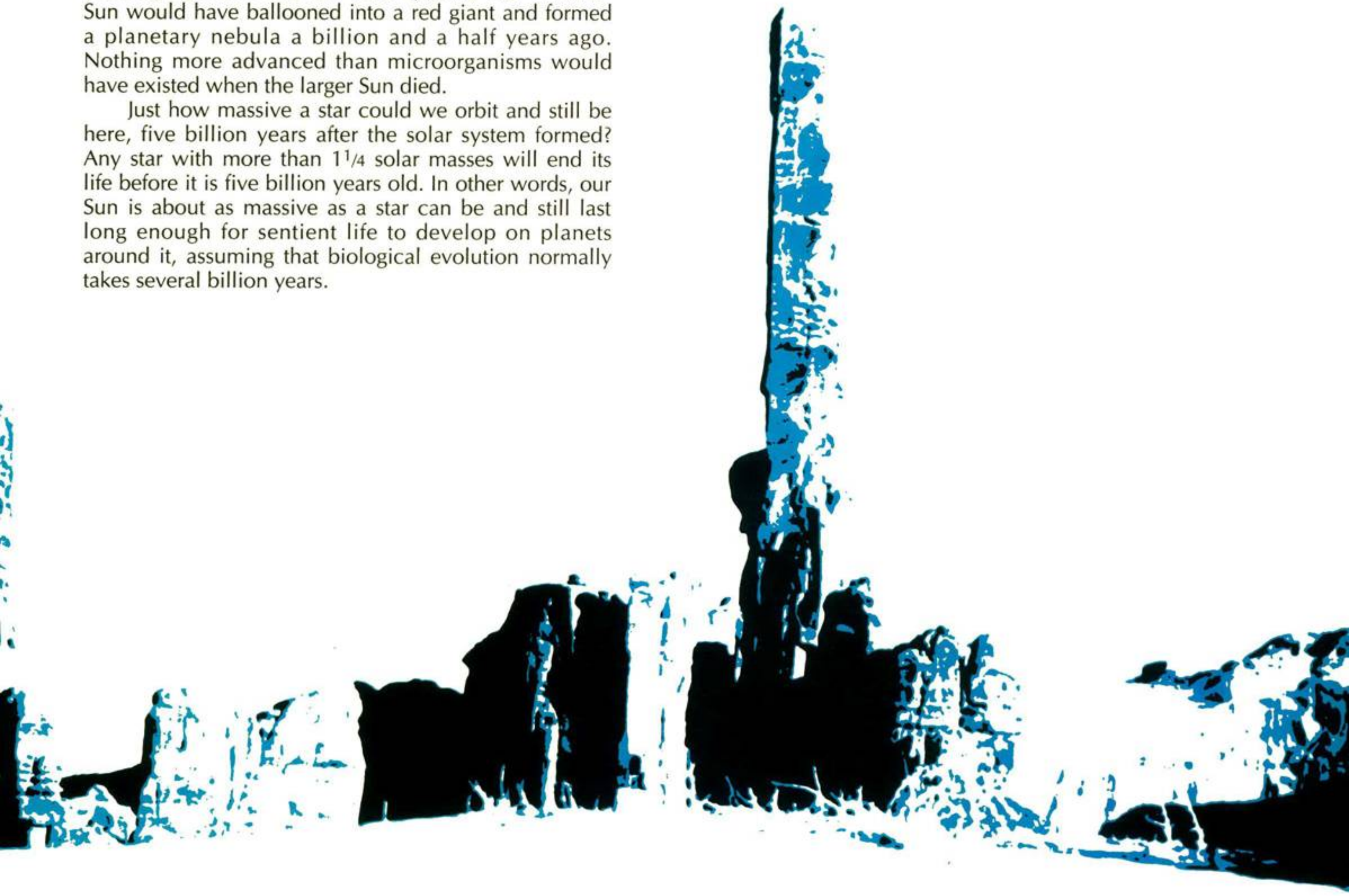
Our new Sun, though more massive, has a similar fate. It, too, will blow off its outer layers, creating an expanding planetary nebula. The difference is that our high-mass Sun has a lifetime of only 3 billion years. If our speculative solar system had started out 4.6 billion years ago (just like the real solar system), our "what if" Sun would have ballooned into a red giant and formed a planetary nebula a billion and a half years ago. Nothing more advanced than microorganisms would have existed when the larger Sun died.

Just how massive a star could we orbit and still be here, five billion years after the solar system formed? Any star with more than 1¼ solar masses will end its life before it is five billion years old. In other words, our Sun is about as massive as a star can be and still last long enough for sentient life to develop on planets around it, assuming that biological evolution normally takes several billion years.

This assumption is by no means certain. For example, geologists have strong evidence from certain layers of the planet's crust that throughout history Earth has been struck by errant asteroids. These impacts could well have been powerful enough to destroy nascent life forms which, if their destruction hadn't occurred, could have evolved into advanced life forms earlier in Earth's history.

Indeed, what if Earth had never experienced mass extinctions? How would life have been different? Or what if the Sun had been a less-massive star? Or Earth had been closer to the Sun? The "what if" game leads to many possible worlds, some of them lifeless, many of them alien, but all of them fascinating. □

Neil F. Comins is a professor of physics at the University of Maine in Orono. His last story in this series was "Seeing the World Through Infrared Eyes," June 1991.



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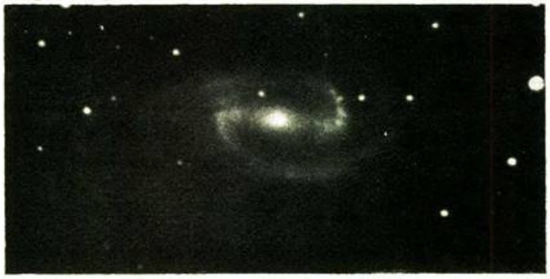

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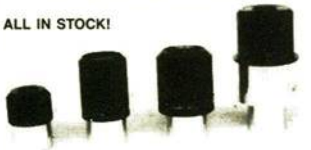

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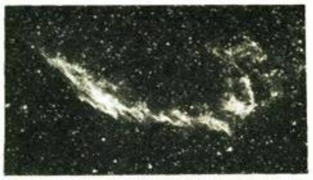

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DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

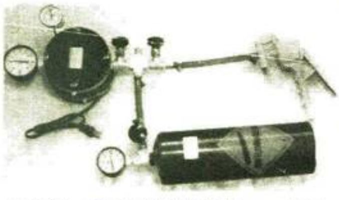
FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$325**



MODEL 600 HYPER-KIT (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$395**

MODEL 1200 HYPER-KIT is for 4X5'' plates and film up to 5X7''. Has 2 gas cylinders and includes temperature controller ... **$595**

Temperature controller for any HYPER-KIT **$65**

Electric Vacuum Pump, Model R-10 **$325**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.
Specify Camera and Telescope type.
U.S. Patent 4,448,500

NEWTONIAN EASY-GUIDER™

Full aperture. Installs in seconds. Specify 2'' or 1¼''.

NEWTONIAN EASY-GUIDER **$169.50**
3X Relay Diagonal (see photo) **$89.50**
Illuminated reticle eyepiece system .. **$99.50**
Guider for Hasselblad **$350,** Mamiya 645 **$199**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad **$198,** Mamiya 645 **$98**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10'' Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) ..... **add $99.95**
Adapter for Hasselblad **$229,** Mamiya 645**$129**
Pentax 6X7 **add $129;** Pentax 645 **add $149**

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosslines, battery pack.

2. Cable release for long exposures .. **$9.95**

3. **LUMICON Quartz Drive Corrector . $219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.
Declination motor (state telescope) .. $99
NEW Deluxe Digital Qtz. Drive Correc. **$298**

Kodak
SR1600
Scotch
Scotch
1000

HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).***No C.O.D.s.***

Film Type, 35mm	**Exposures**	**Price**
2415, Ultra-fine B&W, red sens.	36	**$10.95**
SR-G3200, fastest of all, color neg	24	**$13.95**
Kodak Ektar 1000 fast, fine grain	24	**$12.95**
Fuji HG400 fine grain color neg.	12	**$10.95**
3M 1000, fastest slide film	12	**$12.95**
Fujichrome RD100, fine grain slide	24	**$12.95**
D-19 B&W Developer	1 gal.	**$6.95**

NEW MEADE® ADVANCED PRODUCTS AT LUMICON

"What an astounding combination of high performance and low price!" Jack Marling, Ph.D., owner of LUMICON

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6" f/9 Apochromat
Only $3995

New Meade 6" f/9 Model 152ED Refractor shown with #1697 Computer Drive System.

See the Meade ad in this magazine for full specifications and product descriptions. ED = Extremely low dispersion glass which yields color-free virtually perfect images. PPEC = Permanent Periodic Error Correction "Smart Drive."

Model 102 ED 4" f/9 Apochromat and mount	**$1795**
Model 127 ED 5" f/9 Apochromat and mount	**$2295**
Model 152 ED 6" f/9 Apochromat and mount	**$3995**
Model 178 ED 7" f/9 Apochromat and mount	**$4995**

DRIVE SYSTEMS

#1664 Electronic Drive with PPEC and 2X, 32X slewing system, dual-axis controller	**$295**
#1697 Computer Drive, 747 object computer memory, automatic slewing to desired object	**$595**
8,000 object library of deep-sky targets	**add $99**

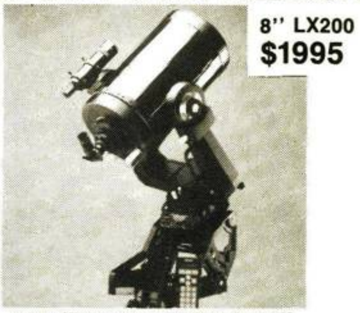
OPTICAL TUBE ASSEMBLIES (OTA)

Model 102 ED/OTA 4" f/9 OTA only	**$1075**
Model 127 ED/APO-OTA 5" f/9 OTA only	**$1595**
Model 152 ED/APO-OTA 6" f/9 OTA only	**$2295**
Model 178 ED/APO-OTA 7" f/9 OTA only	**$2995**

EQUATORIAL MOUNTS

LXD 600 mount and standard field tripod	**$895**
LXD 700 mount and giant field tripod	**$1995**

NEW MEADE LX100 & LX200 SCHMIDT-CASSEGRAIN TELESCOPES



8" LX200
$1995

NEW MEADE 8" LX200 TELESCOPES

See the Meade ad in this magazine for full specifications and detailed product descriptions.

LX100 Drive, 2X, 32X speed control with PPEC (Permanent Periodic Error Correction "Smart Drive") and dual-axis hand controller.

LX200 Drive, Full electronic control with PPEC, 747 object computer memory and automatic computer controlled slewing to desired object.

NOTE: A wedge is **not** needed for visual observing with the LX200 Drive. Specify f/6 or f/10 optics at the *same* price.

8" LX100 Schmidt-Cassegrain with wedge	**$1695**
8" LX200 Schmidt-Cassegrain with computer	**$1995**
Wedge for photographing with LX200	**$110**
10" LX100 Schmidt-Cassegrain with super wedge	**$2395**
10" LX200 Schmidt-Cassegrain with computer	**$2295**
Super Wedge for photography with LX200	**$395**

OTHER SCHMIDT-CASSEGRAINS

Meade 2045D 4" f/10 with motor drive	**$695**
Meade 2080B 8" f/10 with tripod, wedge, MCOG	**$1175**
NEW! Model 2120B 10" f/10 with wedge, tripod, MCOG	**$1595**

PHOTOGRAPHY ACCESSORIES

LUMICON Cassegrain EASY-GUIDER f/6 or f/10	**$225**
Cassegrain EASY-GUIDER for f/6.3 8" telescope	**$195**
LUMICON Giant EASY-GUIDER for 10" f/5-f/10 operation	**$395**
Giant EASY-GUIDER for f/6.3 10" telescope	**$295**

MEADE STARFINDERS

8" f/6
$599*

New 8" f/6 Meade Starfinder telescopes

See the Meade ad in this magazine for full descriptions and technical specifications for 6" to 16" Starfinders. These are complete telescope systems with motor drive, mount, finderscope and 48X eyepiece.

6" f/8 Starfinder 6(add $50 shipping)	**$499**
8" f/6 Starfinder 8 (add $60 shipping)	**$599**
10" f/4.5 Starfinder 10 (add $75 shipping)	**$699**
16" f/4.5 Starfinder 16 (ship. freight COD)	**$1995**

*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated shipping charge to the price. LUMICON showroom prices are $96 higher.

ACCESSORIES

LUMICON carries the full line of Meade accessories. See the Meade ad in this magazine for detailed prices and descriptions.

Meade #43 Single axis drive corrector	**$99**
LUMICON DX200 Dual-axis drive corrector	**$249**
LUMICON DX2BP Dual-axis drive corrector with built-in battery pack	**$299**

LUMICON® SKY VECTOR™

Higher Performance — Lower Price

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SKY VECTOR $399

NEW! With over 200 object memory including the 110 Messier objects.

SKY VECTOR II™ $499

Only the LUMICON SKY VECTOR II has size, **true visual magnitude**, and complete **detailed visual description** for **all** 1500 objects in memory.

NGC SKY VECTOR™ $699

IMPROVED!—2002 Additions / Corrections

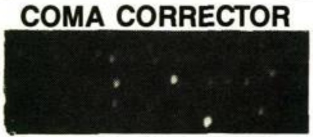
NGC-Sky Vector
ENTER
LUMICON

Improved NGC SKY VECTOR with over 8,500 object memory including complete and corrected RNGC catalogue, and IC and planetary catalogues.

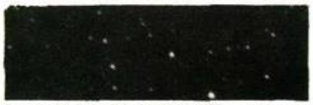
LUMICON NGC SKY VECTOR FEATURES:
- All features of LUMICON SKY VECTOR II
- Complete *corrected* RNGC catalogue
- 740 nonexistent NGC objects identified
- 343 corrections to RNGC catalogue
- 203 best colored & multiple stars
- 140 "Best IC Objects" catalogue
- 308 best planetary nebulae selected by Jack Marling in separate catalogue listing
- 268 best "Non NGC/IC" objects catalogued
- "IDENTIFY" program helps you identify an unknown object seen in eyepiece
- "GUIDE" program leads you to object
- Detailed visual or photographic descriptions
- RS-232 port for computer access
- Includes planets' ephemerides in computer

Specify Telescope Type: Meade 2045, 2080, 2120, C-8, C-11, Odyssey 8, 10, 13, 17½, Alt-Azimuth.
Ultima 8, 11 .. **add $25**, C-14 .. **add $75**

COMA CORRECTOR



Coma 1 inch off-axis 17½" f/4.5



Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. **It threads into LUMICON 2" EASY-GUIDERS for effortless installation.** This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Clear aperture = 1.8".

LUMICON 48mm Coma Corrector/Field Flattener Lens	**$285.00**
LUMICON 2" EASY-GUIDER	**$169.50**
2" EASY-GUIDER (Mamiya 645)	**$199.50**
2" Adapter for Pentax 6x7	**$129.00**
2" Adapter for Hasselblad	**$229.00**
2" Adapter for Bronica SQ-A	**$175.00**
2" Extension for viewing	**$26.00**

2" DELUXE BARLOW

1.8x Multiplier Lens (2" Barlow)

LUMICON 1.8x Multiplier Lens (2" Barlow) **$235.00**

LARGE UV/DUST SEAL

Protect the optics of your 8-14" Schmidt-Cassegrain with a UV/Dust Seal. Simply thread it onto the rear cell, then attach all normal accessories. The large size fits Meade 2120, Celestron-11 and -14 & has a high quality multi coated (removable) 72mm UV filter.

UV/Dust Deal for Celestron C-8	**$39.00**
UV/Dust Seal for Meade 2080	**$56.00**
UV/Dust Seal (large) for Meade 2120	**$89.50**
UV/Dust Seal for Celestron-11, -14	**$89.50**

NEW! LOW PROFILE HELICAL FOCUSERS

FROM $59.50

LUMICON® LOW PROFILE FOCUSERS

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.

Select your desired base-plate shape! Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD.

LUMICON 1¼" Helical Focuser	**$59.50**
LUMICON 2" Helical Focuser 1½" high	**$65.00**
LUMICON Non-rotating Helical Focuser	**$129.00**
2" rack & pinion focuser, only 2" high	**$139.00**
3 handles for non-rotating focuser	**$12.95**
2"/1¼" adapter w/48mm filter threads	**$20.00**
2" LUMICON EASY-GUIDER	**$169.50**

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

1¼" 50mm Finderscope **$59.50**, right-angle	**$89.50**
1¼" straight-thru 80mm SUPER-FINDER	**$169**
1¼" right-angle 80mm SUPER-FINDER	**$179.50**
1¼" right-angle version, w/star diagonal	**$209**
25mm Cross-hair 1¼" eyepiece (12X)	**$39**
1¼" Star Diagonal **$39**, Mounting Brackets,	**$37**
1¼" Amici Prism diag. for correct left-right views	**$69.50**

LOTS OF ADAPTERS

2" adapter for C-8, Meade 2080, etc.	**$26.00**
2" adapter for C-80, C-100 refractor	**$39.50**
2" adapter for C-70, C-80F, C-100F fluorite	**$39.50**
2" adapter for C-6, Comet Catcher, Meade 312	**$30.00**

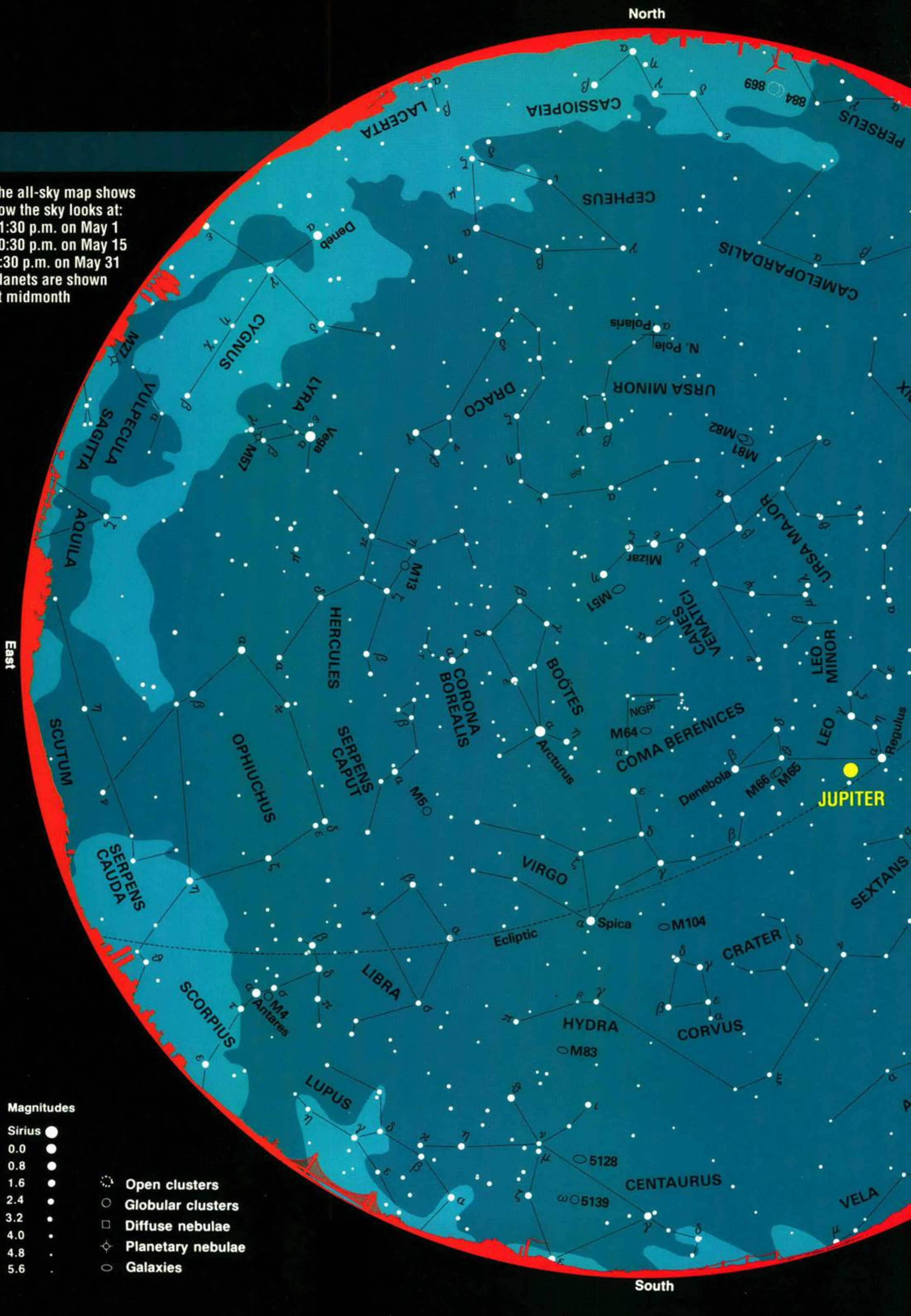
EXTENSION TUBES

1" long 1¼" OD thread-in extension	**12.00**
2½" long extension (holds 1¼" filters)	**16.00**
4½" long extension for 1¼" eyepieces	**$25.00**
3" long extension for 2" eyepieces*	**$26.00**
2" long extension for 2" eyepieces*	**$26.00**

VIEWING ADAPTERS

2"/1¼" reducing bushing,threaded 48mm*	**$20.00**
2"/T-thread adapter, threaded 48mm*	**$25.00**
T-thread/1¼" adapter	**$25.00**
F/10 2" or 1¼" eyepiece viewing adapter for Giant Easy-Guider	**$39.50**
Low profile star diagonal eyepiece holder	**$16.00**
Meade 2" Diagonal/Giant Easy-Guider	**$39.50**

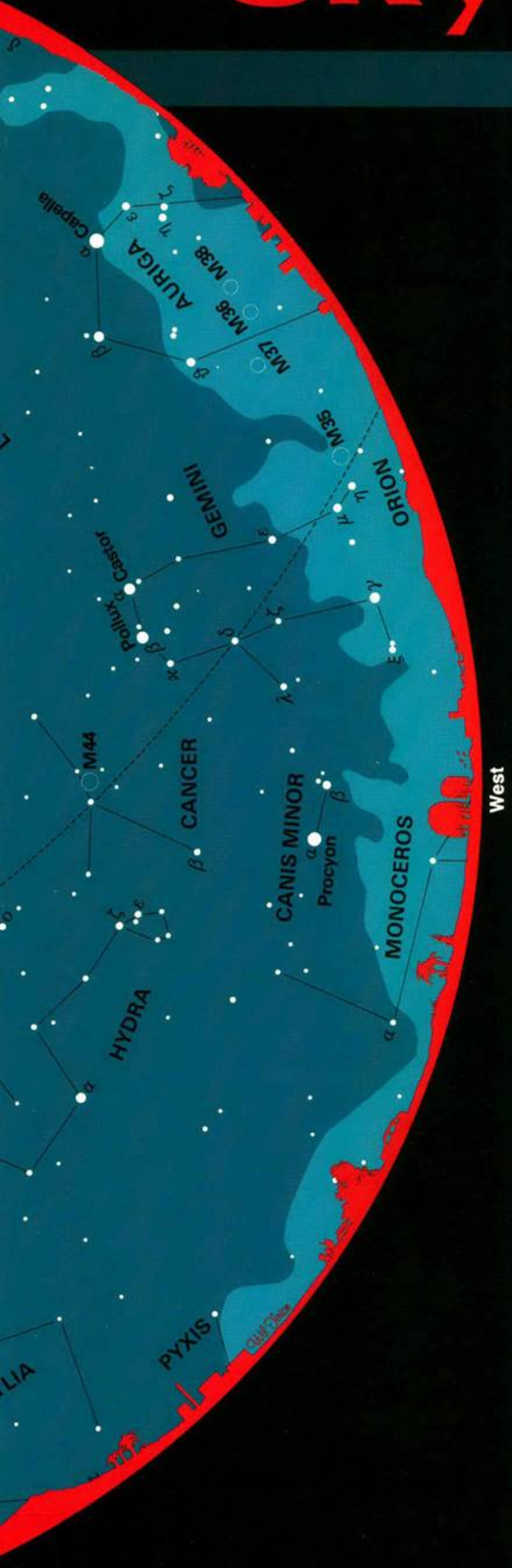
**Threaded to hold 48mm filters.*


North
East
South
CASSIOPEIA
LACERTA
PERSEUS
CEPHEUS
CAMELOPARDALIS
Deneb
CYGNUS
M27
VULPECULA
SAGITTA
LYRA
Vega
M57
DRACO
Polaris
N. Pole
URSA MINOR
M82
M81
AQUILA
M13
HERCULES
Mizar
URSA MAJOR
M51
CANES VENATICI
LEO MINOR
CORONA BOREALIS
BOÖTES
NGP
M64
COMA BERENICES
Arcturus
LEO
Regulus
Denebola
M66
M65
JUPITER
SCUTUM
OPHIUCHUS
SERPENS CAPUT
M5
SERPENS CAUDA
VIRGO
SEXTANS
Spica
M104
Ecliptic
CRATER
LIBRA
SCORPIUS
M4
Antares
HYDRA
CORVUS
M83
LUPUS
5128
CENTAURUS
ω 5139
VELA
869
884
Magnitudes
Sirius
0.0
0.8
1.6
2.4
3.2
4.0
4.8
5.6
Open clusters
Globular clusters
Diffuse nebulae
Planetary nebulae
Galaxies

The all-sky map shows how the sky looks at:
11:30 p.m. on May 1
10:30 p.m. on May 15
9:30 p.m. on May 31
Planets are shown at midmonth

Sky Almanac

May 1992



ETA AQUARIDS PEAK ON MAY 4

Many meteors should grace the predawn sky of May 4, when the Eta Aquarid meteor shower is at its peak. Expect to see from 10 to 40 meteors per hour that morning and perhaps half that number the mornings of May 3 and 5. The Eta Aquarids could be the best meteor shower of 1992, because moonlight interferes with both the Perseid and Geminid showers.

PLUTO AT OPPOSITION

The smallest and normally most distant planet reaches opposition on May 11/12, when it is brighter and easier to see than at any other time this year. Still, you'll need at least an 8-inch telescope and a dark sky to spot this elusive, 14th-magnitude planet.

SPOTTING THE YOUNG MOON

May brings with it an excellent opportunity to view a one-day-old Moon. On the evening of May 3, the young Moon will appear as a slim crescent very low in the western twilight about 30 minutes after the Sun sets.

A STRIKING TRIO OF OBJECTS

The Moon, Jupiter, and Regulus all lie near one another on the evenings of May 9 and 10. The First Quarter Moon lies below and to the right of the planet and star in the evening sky on the 9th, while a slightly gibbous Moon appears below and to the left of the other two objects on the 10th.

Calendar of Events

1 Jupiter is stationary
2 New Moon is at 1:44 p.m. EDT
4 Eta Aquarid meteor shower peaks
8 The Moon is at perigee (229,650 miles from Earth), 7:42 a.m. EDT
9 First Quarter Moon is at 11:43 a.m. EDT
11 Pluto is at opposition
16 Full Moon is at 12:03 p.m. EDT
17 Mars is at perihelion (128.4 million miles from the Sun)
23 The Moon is at apogee (251,233 miles from Earth), 12:53 a.m. EDT
The Moon passes 5° north of Saturn, 8 a.m. EDT
24 Last Quarter Moon is at 11:53 a.m. EDT
27 Asteroid Metis is at opposition
28 Asteroid Herculina is at opposition
Saturn is stationary
31 Mercury is in superior conjunction
New Moon is at 11:57 p.m. EDT

Eye on the Sky

by Deborah Byrd

1992'S BEST METEOR SHOWER

In early May, the Moon pops into view as a slim crescent after sunset, and meteors streak across the sky before dawn. With no Moon in the predawn sky to obliterate the view, conditions are nearly perfect for this year's Eta Aquarid meteor shower. In contrast, the nearly Full Moon wipes out both the Perseids and Geminids later this year. The Eta Aquarids peak on the morning of May 4, when you can expect to see anywhere from 10 to 40 meteors per hour. Because the peak of the shower is fairly broad, however, you can still see a reasonably good show on the mornings of the 3rd and 5th.

All Eta Aquarid meteors appear to radiate from the vicinity of the star Eta in the constellation Aquarius, the Water Carrier. However, don't assume that you should stare toward the radiant to see the most meteors. Most meteors don't become visible until they are some 30° away from the radiant. Because the meteors can appear in any part of the sky, just relax and let your eyes rove attentively among the stars.

The number of meteors you'll see during a shower depends critically on the altitude of the shower's radiant. If you imagine meteors streaming out in all directions from the radiant, you can see why it's best to watch when the radiant is high in the sky. When the radiant is low, some meteors will zoom off below your horizon. For observers at 40° north latitude, the Eta Aquarid radiant rises around 2:30 a.m. and is highest in the sky after sunrise. At lower latitudes, the radiant is correspondingly higher. That's why you'll want to watch for the Eta Aquarids as close to the beginning of morning twilight as you can.

Eta Aquarid meteors are often yellow in color and typically make long streaks across the sky that leave behind glowing trails. They also move very fast — 42 miles per second — because they crash into our atmosphere from a direction nearly head-on to Earth's orbit around the Sun. To view the Eta Aquarids, follow the usual rules: observe from an open area that is far from city lights and bring a jacket or blanket to keep you warm. (For more on observing the Eta Aquarids, see "Watching Halley's Debris" by Philip M. Bagnall on page 78.)

THE YEAR'S EASIEST YOUNG MOON

Last month I told you how to spot the Moon less than 24 hours after it passed between the Sun and Earth. Whether you saw April's young Moon or not, look again on the evening of May 3 for a slightly older Moon. This month the young Moon is just over 30 hours old for those in the United States and Canada, which will make it much easier to see than April's young Moon was.

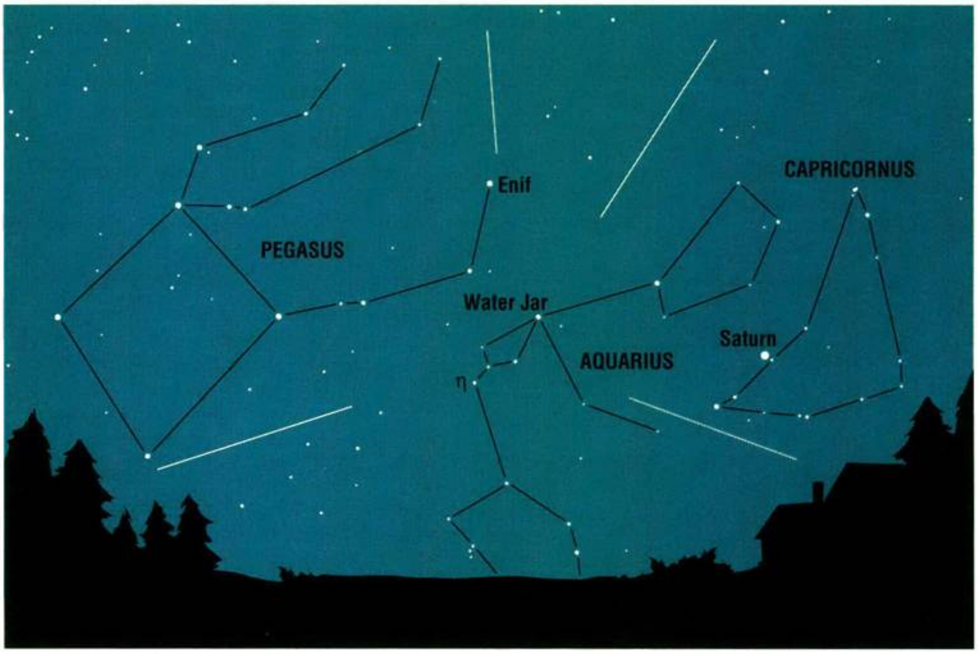
When moonlight drowns out a meteor shower or hides favorite deep-sky objects from view, how we rail against it! But the Moon is a lovely sight when it appears as a slim crescent in a pale western twilight sky. The soft glow on the otherwise dark portion of such a Moon is called earthshine. It's really sunlight that has reflected off Earth onto the Moon, which in turn reflects it back to Earth. When we see a crescent Moon, someone standing on the Moon would see a nearly full Earth. Earthshine illuminates the lunar

A SLENDER CRESCENT MOON poses above the mountains near Los Angeles in Ivan Dryer's April 6, 1989 photo. Observers in North America can see a comparable day-old Moon on the evening of May 3.

landscape just as moonlight can light our way near the time of the Full Moon.

THE MOON, A PLANET, AND A STAR

Don't miss an eye-catching gathering of three objects on the evenings of May 9 and 10. Throughout the first half of May, the largest planet in our solar system, Jupiter, lies about 5° from the bright star Regulus. On the 9th and 10th, the Moon joins the pair. The three make a striking sight high in the southwest after sunset and continue to ornament the sky until they set in the west after midnight. I always enjoy contemplating the distances of objects during these celestial gatherings. A beam of light from the Moon takes a bit over one second to reach Earth. On May 10, the light reaching us from Jupiter has completed a 42-minute journey. But the light from the star Regulus has been traversing interstellar space for 85 years.



LONG PATHS and glowing trails characterize the Eta Aquarid meteors. You can expect to see up to 40 meteors per hour radiating from the Water Jar asterism in Aquarius before dawn on May 4.

MAY'S PLANETS

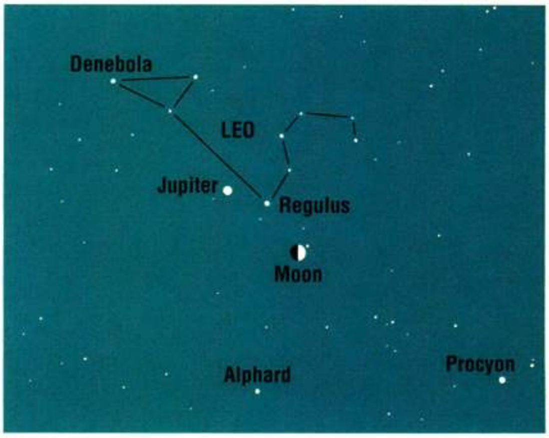
The evening sky in May is dominated by the bright planet **Jupiter**. This starlike point of light lies high in the southwest when night begins, but at magnitude –2.1 it is far brighter than any star. In fact, one of the sky's brighter stars — Regulus — has been visible near Jupiter all year. On May 1, however, Jupiter begins creeping slowly eastward against the background stars. The distance between it and Regulus increases throughout the month, and the two won't approach near one another again until the year 2003.

The next bright planet to appear is **Saturn**, which rises around 1:30 a.m. daylight time in mid-May. You can find the ringed planet in the southeast as morning twilight brightens. Though it is not spectacularly bright at magnitude 0.7, Saturn easily outshines the stars of its host constellation, Capricornus. The planet will grow brighter as it approaches opposition in August, when it will shine at magnitude 0.2.

Mars finally appears in a dark sky this month, rising shortly before morning twilight commences. It lies low in the east before sunrise, a fairly inconspicuous, ruddy light among the stars of Pisces. Mars is still quite far from Earth, and we'll spend the rest of the year catching up to it. Yet the Red Planet does do something exciting this month, at least from a heliocentric point of view. It reaches perihelion on May 17, when it is closest to the Sun during its nearly two-year-long orbit. On that date Mars lies 1.4 astronomical units from the Sun, or 1.4 times the average distance between the Sun and Earth. But for Earthbound observers, the 1st-magnitude planet now appears but a shadow of its future self. By the end of the year, the planet will have brightened tenfold, to magnitude –1.4, and will dominate the mid-evening sky.

For viewers in mid-northern latitudes this month, **Mercury** and **Venus** are extremely hard to see. Both are nearing superior conjunction, when they lie on the opposite side of the Sun from Earth, and thus are very low in the predawn sky. Your best bet for seeing them is on May 1, when from 40° north latitude Mercury lies 3° above the eastern horizon 30 minutes before sunrise and Venus rises 25

AND THE MOON MAKES THREE when it passes near Jupiter and Regulus on May 9. The trio lies high in the southwest as darkness falls and remains visible until after midnight.



minutes before the Sun. After the 1st, the two planets essentially disappear. Mercury reaches superior conjunction on May 31 while Venus, traveling at a more leisurely pace, comes to superior conjunction in mid-June.

THE STARRY SKY

One of the most beautiful of all constellations is Corona Borealis, the Northern Crown. You can find this constellation on May evenings ascending in the east, not far from the kite-shaped constellation Bootes. Corona Borealis is easy to pick out in a dark sky — its stars form a small but distinct semicircle that early stargazers imagined as a crown.

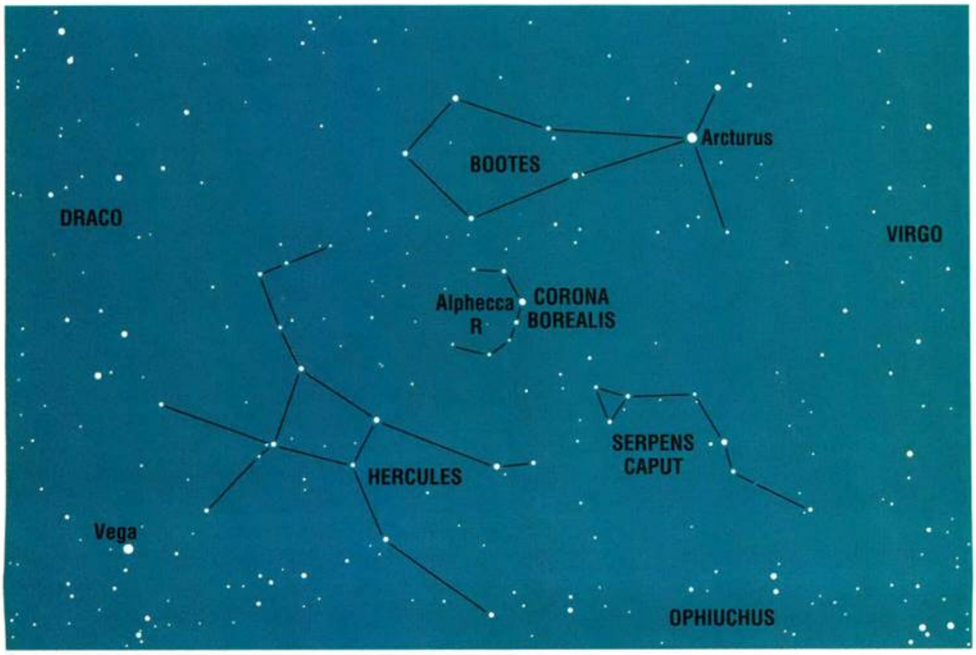
In mythology, this celestial crown is supposed to have been worn by the beautiful Ariadne, who was the daughter of Minos, the second King of Crete. Legend says that Ariadne helped King Theseus of Athens find a way to escape the dreaded Minotaur. The Minotaur — a half man and half bull — was fond of chasing young men and women through a maze and then eating them! Ariadne gave Theseus a ball of string to help him find his way through the maze. She also gave him a sword, which he used to kill the Minotaur.

Afterward Theseus agreed to marry Ariadne, who loved him dearly. The two then fled to Naxos, where Theseus abandoned her. After that, her history becomes unclear. Some say the crown was given to Ariadne by Dionysus, the god of wine, and that it was transformed into the constellation after her death. Alluding to Ariadne and Corona Borealis, 16th-century poet Edmund Spenser in *The Faerie Queene* shows the link between astronomy, legend, and literature: "Look how the crowne which Ariadne wore / Upon her yvory forehead . . . / [is] now placed in the firmament. . . ."

The brightest star in Corona Borealis is Alphecca, a magnitude 2.2 star near the middle of the constellation's semicircle. Alphecca is also commonly called Gemma, which can get a little confusing. Despite this apparent split personality, there's no mistaking that this star is the brightest jewel in the crown.

Alphecca isn't the only intriguing star in Corona Borealis. The constellation also contains the variable star R Coronae Borealis (R Cor Bor), which was discovered in 1795. This star is normally just bright enough at magnitude 6 to be glimpsed by the naked eye from a dark-sky site. But occasionally it fades several magnitudes, dropping to as faint as 14th magnitude. R Cor Bor can remain at 6th magnitude for years at a time, while it is typically at minimum brightness for several months. But the star is an irregular variable and no one knows for sure when it will be bright and when it won't. Take a few minutes this month to check on this mysterious star. Can you see it within the semicircle of Corona Borealis (see the map at left for its precise location)? Or has it faded below naked-eye visibility, only to return at some unknown date in the future? ☐

A BEAUTIFUL SEMICIRCLE of stars known as Corona Borealis nestles between the larger constellations of Bootes and Hercules. During May, you can find Corona Borealis high in the east at mid-evening.



Deborah Byrd's new radio series, "Earth and Sky," can be heard on stations in the United States, Canada, and Guam.

Through the Eyepiece by Jeff Kanipe

SATURN'S RINGS IN THE SPOTLIGHT

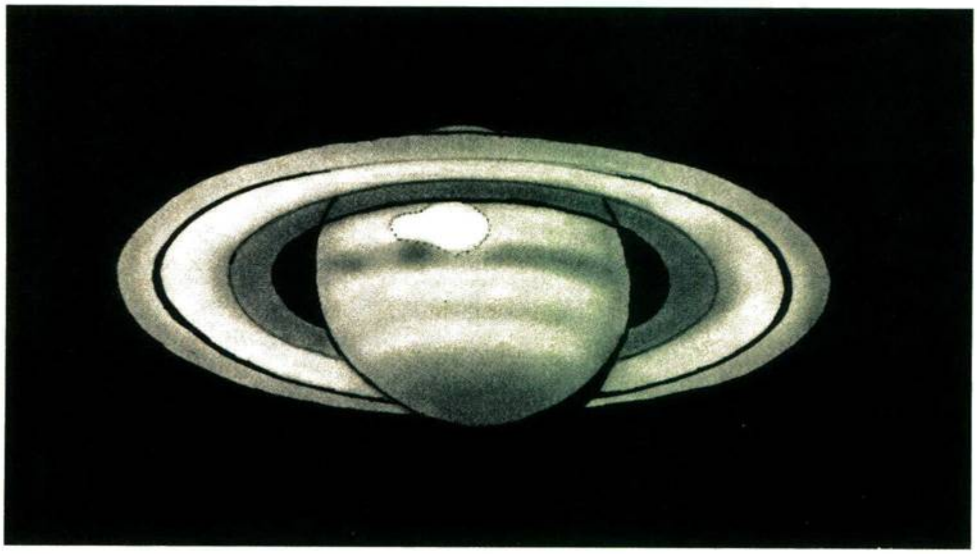
After a long winter that provided few good views of Saturn, the ringed planet returns to prominence this month. Still in Capricornus and fairly low in the southeast before dawn, Saturn is a fascinating object for two reasons.

First, Saturn's rings reach their minimum tilt for the year in late May — a little less than 15°. The rings were at their maximum tilt in 1988, when they were inclined 27° with respect to Earth. But now that angle is decreasing to the point that the rings will appear edge-on in 1995, as they were in 1980.

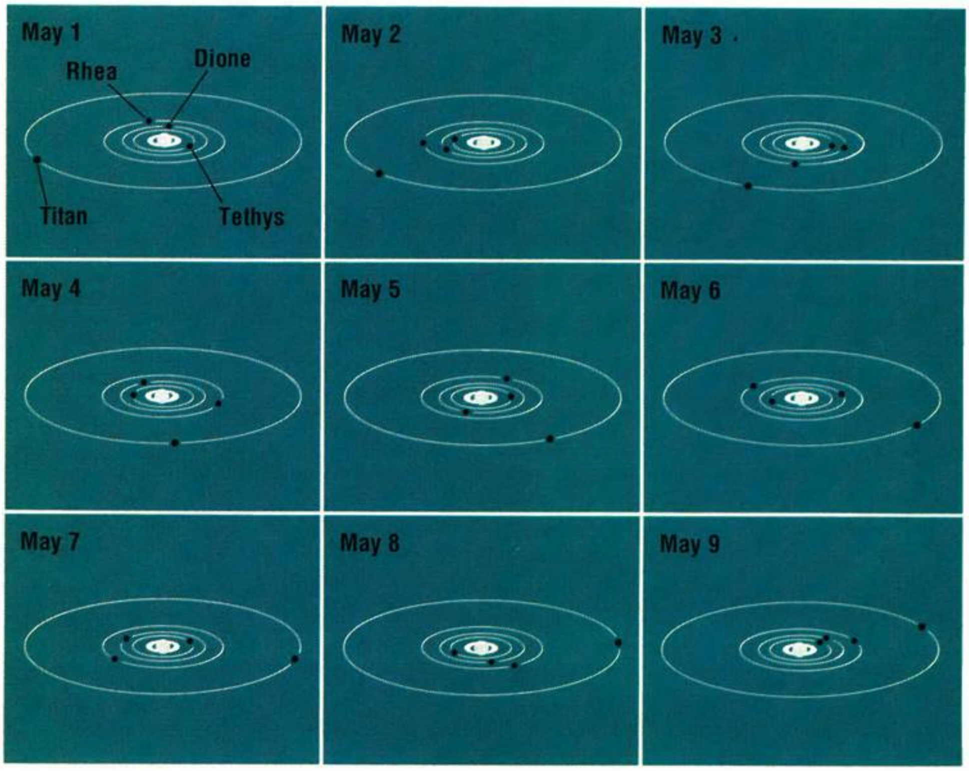
The rings appear edge-on whenever Earth's orbit intersects the plane of Saturn's ring system, which itself is inclined 27° to the plane of that planet's orbit. The edgewise appearance occurs at intervals of 13.75 years and 15.75 years during Saturn's 29.5-year orbit. The unequal periods result from the planet's changing velocity as it travels along its elliptical orbit. During the 13.75-year period, we see the planet's southern hemisphere exposed. During the 15.75-year period, Saturn's north pole is tilted toward Earth (as it is now).

A second good reason to check out Saturn now is that it, Earth, and the Sun make a right angle in space — an alignment known as quadrature. At this configuration, you can easily see Saturn's inky shadow as it falls dramatically across the rings behind and to one side of the disk. In May, we are looking at the planet approximately three months before opposition, so we see the narrow, angular shadow cast west of the disk. As Saturn moves toward opposition on August 7, the shadow dwindles, only to reappear on the east side of the disk in the months following opposition. Because of this shadow play, no other planet possesses quite the three-dimensional quality Saturn does.

There's one more good reason to begin observing Saturn in earnest now. Since 1986, Saturn has been skimming along the southern part of the ecliptic, never venturing north of –19° declination. So the planet hasn't been very well-placed for observers in the Northern Hemisphere. This year, however, Saturn makes some real progress to the north, creeping up to –16° declination in May. This northward



SATURN'S SHADOW darkens the rings slightly this month, as it did in 1990 (above). Sketch by Jean Dragesco. Also look for Saturn's bright moons (below; positions are shown at 5 a.m. EDT with south at top).



movement puts Saturn higher in the sky for northern observers, which should translate into slightly steadier telescopic images. You can test this by looking for Saturn's bright satellites (not counting Titan, which is always easy to see). If the sky is free of haze, a 60mm telescope should pull in 9.7-magnitude Rhea, but you will need a larger aperture to glimpse Tethys (magnitude 10.2) and Dione (10.4). A 5-inch or larger scope under good observing conditions will show these three as glints of light hovering near Saturn's disk like fireflies around a lantern.

WHAT'S JUPITER'S ANGLE?

Jupiter reigns high in the southwest after sunset this month and, as it so happens, is well-placed not only for the telescope but in the solar system as well. As I've often stated, Jupiter never fails to please. But now, three months past opposition, the planet exhibits an appealing shadow show that should interest most observers.

Late this month Jupiter, like Saturn earlier in the month, reaches quadrature. This has two effects: First, Jupiter displays its greatest phase angle as seen from Earth. The phase angle is the angle between the directions of Earth and the Sun as seen from the planet. The greater this angle, the greater the fraction of the planet's visible hemisphere that appears dark. Mars' maximum phase angle, for example, is 47°, while Jupiter's is only about 12°. (The angle is successively smaller the more distant the planet because Earth appears closer to the Sun.) So with the exception of Mars, which near quadrature is obviously gibbous, the outer planets show nearly their full phases at all times.

Technically speaking, however, Jupiter's phase lies somewhere between a generous gibbous and full. Look carefully at Jupiter's eastern limb and see if it appears a bit softer than the planet's hard-edged western limb. If it does, you've seen the phase effect, and you'll know that your telescope and observing eye are working to near perfection.

The second effect of quadrature is more obvious to observers. With the gas giant being lit more from the side than usual, it casts its shadow a greater distance to one side of its globe. Thus, when a moon passes into Jupiter's shadow, from our vantage point it does so farther from the planet's disk, where it is much easier to view. This month observers in North America can watch Jupiter's brightest moon, Ganymede, pass into Jupiter's shadow on two occasions — on the nights of May 10/11 and May 17/18.

On the 10/11th, Ganymede goes into eclipse at 10:21 p.m. EDT and reappears from eclipse at 1:47 a.m. EDT (10:47 p.m. PDT). Observers in the eastern and central time zones can see both the disappearance and reappearance, while those in the mountain and pacific time zones will miss Ganymede passing into the shadow but will see it come out of the shadow.

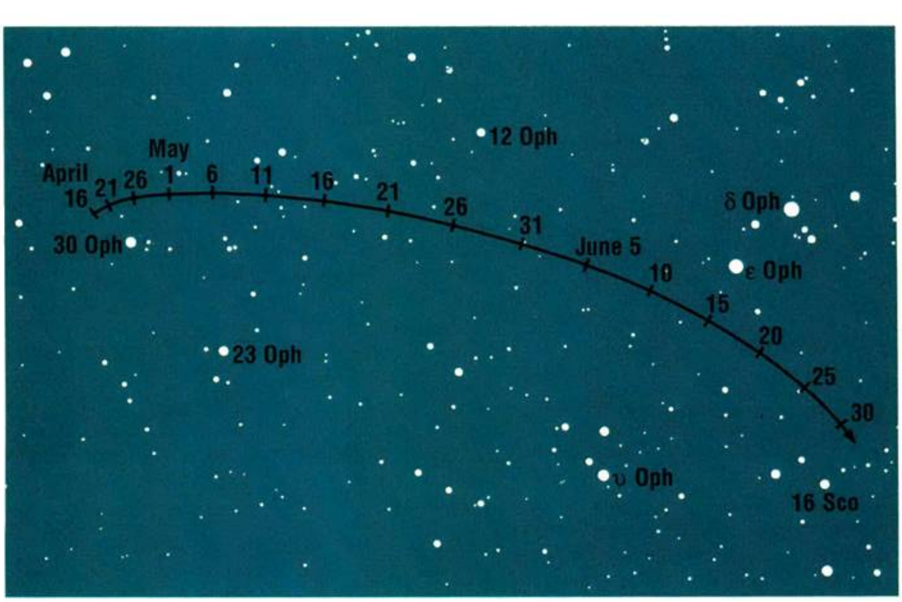
The eclipse on May 17/18 is not quite as favorable as the event a week earlier. This time, Ganymede disappears into Jupiter's shadow at 2:20 a.m. EDT (11:20 p.m. PDT), an event visible from throughout North America. It reappears a little over three hours later (at 5:45 a.m. EDT or 2:45 a.m. PDT), which unfortunately is after Jupiter sets.

After opposition, Jupiter's

COORDINATES FOR HERCULINA

Date	R.A. (2000)	Dec.
April 16	17h03.7m	−3°44'
April 21	17h02.7m	−3°35'
April 26	17h00.9m	−3°28'
May 1	16h58.4m	−3°23'
May 6	16h55.3m	−3°22'
May 11	16h51.6m	−3°24'
May 16	16h47.5m	−3°31'
May 21	16h43.0m	−3°41'
May 26	16h38.4m	−3°56'
May 31	16h33.6m	−4°16'
June 5	16h28.9m	−4°39'
June 10	16h24.5m	−5°07'
June 15	16h20.3m	−5°38'
June 20	16h16.6m	−6°13'
June 25	16h13.5m	−6°50'
June 30	16h10.9m	−7°30'

WESTERN OPHIUCHUS is home to asteroid 532 Herculina during May and June. This minor planet reaches opposition on May 28/29, when it shines at 9th magnitude. Positions are shown for midnight EDT (11 p.m. CDT, 10 p.m. MDT, and 9 p.m. PDT).



shadow is always cast east of its disk. Ganymede thus appears east of Jupiter at eclipse time and is moving away from the planet's disk. In a Newtonian reflector, which inverts the image, south is up and east is to the right. With catadioptric and refracting telescopes equipped with a star diagonal, the view is mirror-reversed.

TELESCOPIC PLANETS

The two inner planets are essentially lost from view this month for observers at mid-northern latitudes. You might glimpse **Mercury** on the 1st, when it lies 3° above the eastern horizon half an hour before sunrise, but count yourself lucky if you can make out its 7.0"-diameter, 56-percent-lit disk. **Venus** is even harder to observe, rising in the east just 25 minutes before the Sun.

The observing situation improves noticeably, however, for our outer neighbor, **Mars**. Observers of the Red Planet may recall that in 1988 one or two dust storms swirled across the surface of Mars, a result of powerful wind currents generated by increased solar heat as the planet approached perihelion. This year, Mars comes to perihelion on May 17, so now is a good time to begin looking for dust storm activity on the planet's surface.

Because Mars has an apparent diameter of only 5" this month, a global dust storm is about all a person with a small telescope can see right now. With a disk size this small, the best way to judge if a dust storm is occurring is by color. For example, if the planet is its usual orange hue one night but appears bright yellow a week later, you can infer that a major dust storm is in progress. These yellow dust clouds appear even brighter if you use a yellow filter, like a Wratten #12.

Uranus and **Neptune** rise nearly two hours before Saturn this month and are well-placed for observation after midnight. Uranus glows at magnitude 5.7 and its blue-green disk measures 3.7" across. Blue-gray Neptune appears even fainter and smaller — glowing at magnitude 7.9 and sporting a 2.3"-diameter disk.

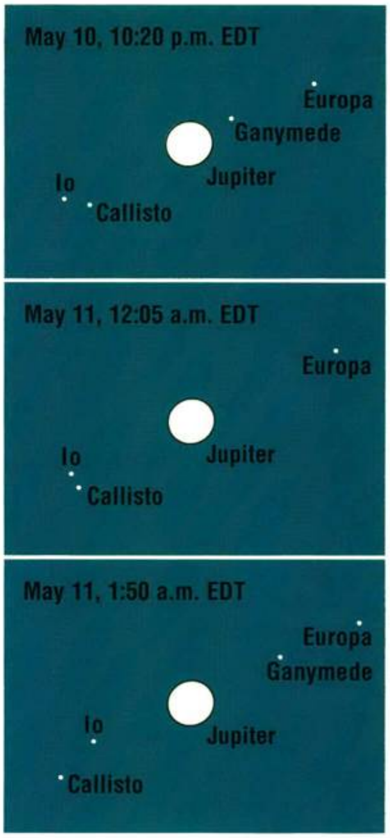
You say you've seen all the planets in the solar system? All save **Pluto**, that is? Well, you're in luck. This month you can finally put that last notch in your telescope, right next to the ones for Uranus and Neptune. Tiny Pluto comes to opposition on the night of May 11/12. It is at this time (and in the weeks prior to and following this period) that Pluto is brightest and most favorably positioned for observing, though you'll still need an 8-inch telescope to spot the 14th-magnitude point of light. For a complete guide on how to find and observe Pluto, see "In Pursuit of Pluto" on page 73.

ASTEROIDS IN THE EYEPIECE

Minor planet enthusiasts will want to exploit the moonless nights in early and late May to scan the western realm of Ophiuchus for the asteroid **532 Herculina**. At the beginning of the month, this 150-kilometer-wide chunk of space rock glows dimly at magnitude 9.4 as it nips a degree north of the globular cluster M10. Herculina reaches opposition on May 28/29, when it peaks at magnitude 9.1. On that night it lies some 4° east of Delta and Epsilon Ophiuchi. After opposition, Herculina moves leisurely toward the southwest.

Look for Herculina in the usual way. Find the asteroid's field with the aid of the finder chart or table of coordinates on the opposite page and then make a detailed sketch of that field using an eyepiece with about a 1° true field of view. A few nights later, return to this field and compare the star positions. The "star" that has moved is Herculina. □

A former associate editor of ASTRONOMY, Jeff Kanipe is the editor of Star Date *magazine, which is published by McDonald Observatory at the University of Texas at Austin.*



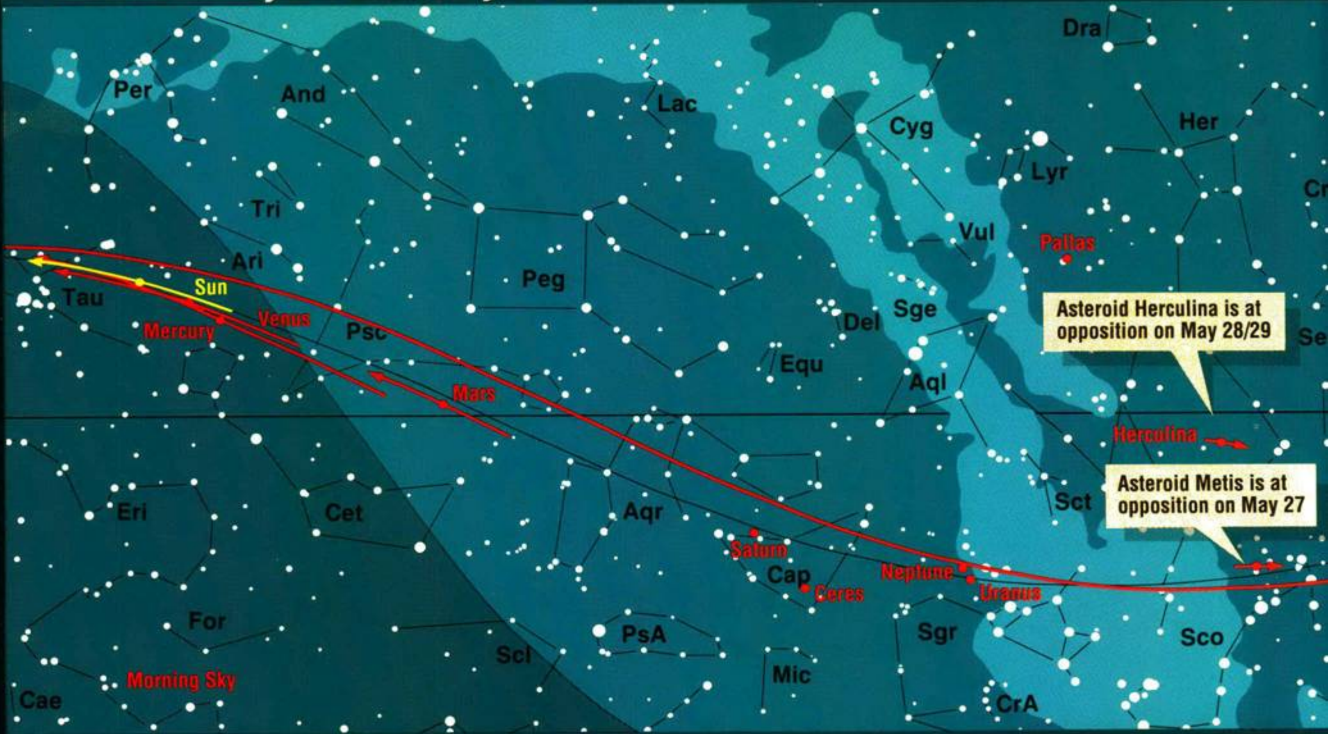
JUPITER ECLIPSES GANYMEDE on the night of May 10/11, when the Galilean moon disappears from view for over two hours. South is at top to match the view in an inverting telescope.

GREAT RED SPOT TRANSIT TIMES

Date	Time
May 3	1:21 a.m.
May 5	3:00 a.m.
May 8	12:30 a.m.
May 10	2:08 a.m.
May 12	3:47 a.m.
May 12	11:39 p.m.
May 15	1:18 a.m.
May 17	2:56 a.m.
May 20	12:27 a.m.
May 22	2:06 a.m.
May 24	11:36 p.m.
May 27	1:15 a.m.

The Red Spot on Jupiter can be seen for about two hours before and after the transit times listed. All times are EDT; subtract 1 hour to convert to CDT, 2 hours for MDT, and 3 hours for PDT.

The Solar System May 1992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Sct
Eri
Cet
Aqr
Saturn
Cap
Ceres
Neptune
Uranus
Sgr
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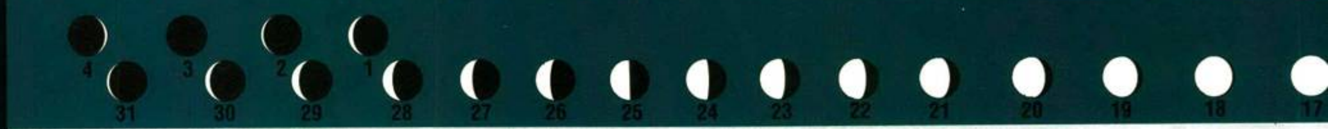
Morning Sky
Cae
CrA

Asteroid Herculina is at opposition on May 28/29

Asteroid Metis is at opposition on May 27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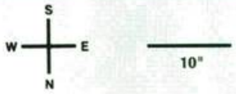
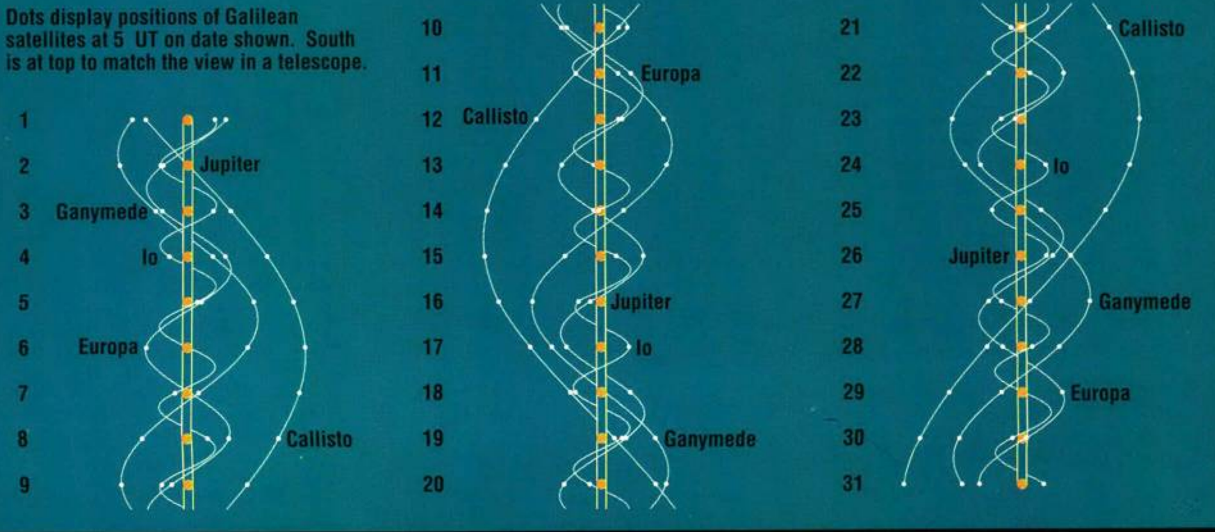
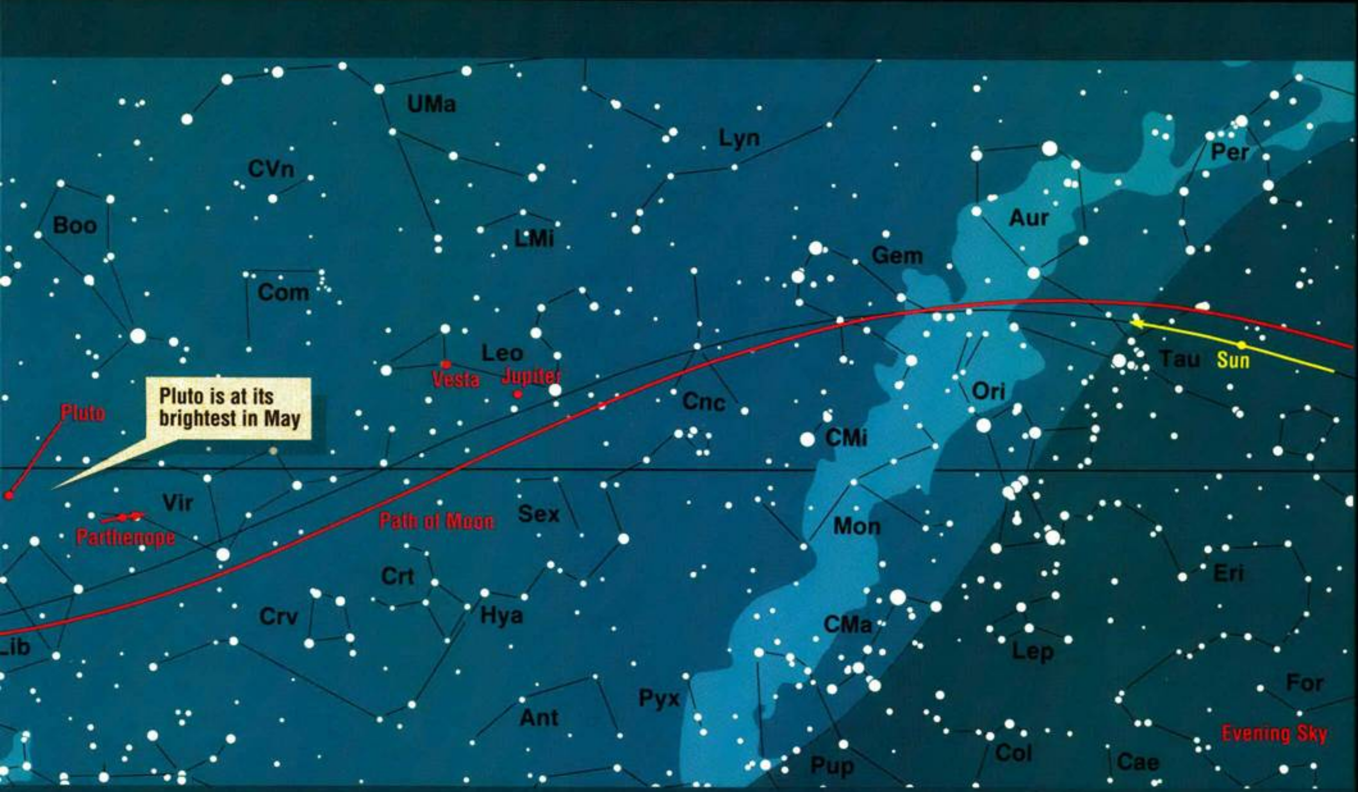


Planet	MERCURY	MERCURY	VENUS	MARS
Date	May 1	May 15	May 1	May 15
Magnitude	+0.2	−0.6	−3.9	+1.0
Angular Size	7.0"	5.7"	9.9"	5.1"
Illumination	56%	78%	98%	92%
Distance (AU) from Earth	0.962	1.177	1.683	1.847
Distance (AU) from Sun	0.446	0.379	0.726	1.381
Right Ascension (2000.0)	1h00.1m	2h20.1m	1h50.9m	0h28.1m
Declination (2000.0)	3°15'	11°47'	10°00'	1°35'

Jupiter's Moons

Dots display positions of Galilean satellites at 5 UT on date shown. South is at top to match the view in a telescope.

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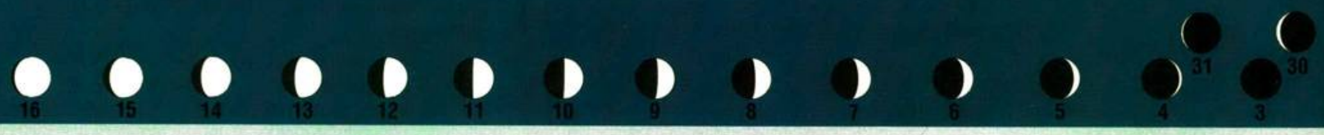
Pluto is at its brightest in May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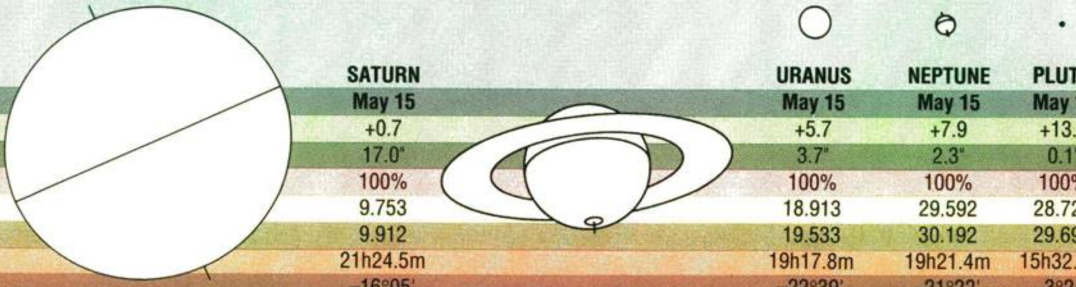
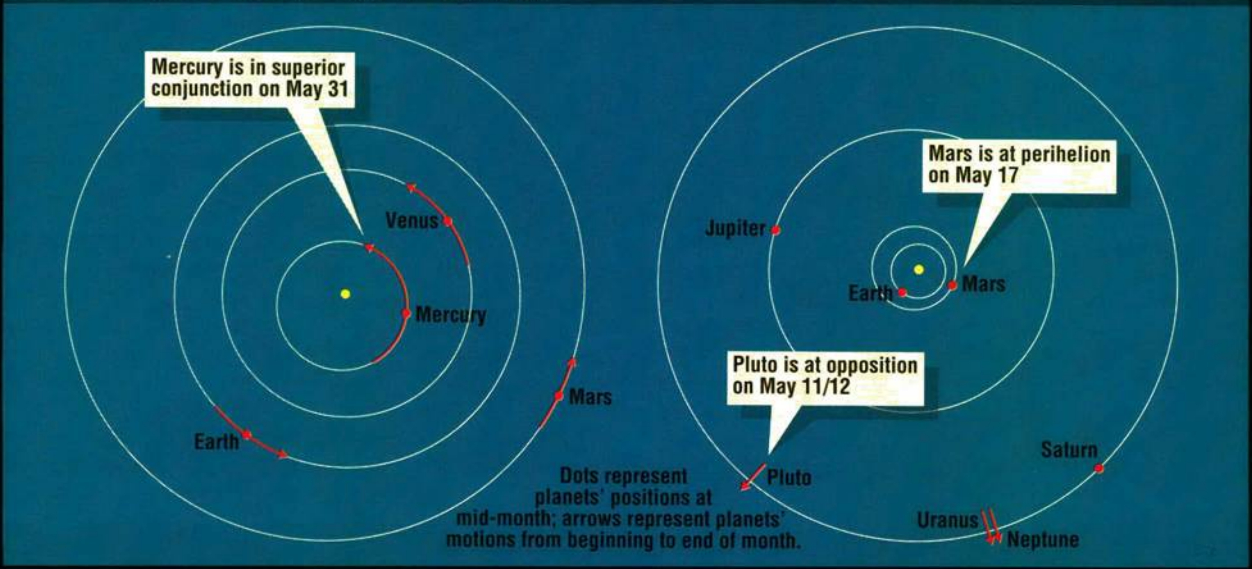


JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
May 15	May 15	May 15	May 15	May 15
−2.1	+0.7	+5.7	+7.9	+13.7
38.3"	17.0"	3.7"	2.3"	0.1"
99%	100%	100%	100%	100%
5.141	9.753	18.913	29.592	28.723
5.417	9.912	19.533	30.192	29.698
10h29.4m	21h24.5m	19h17.8m	19h21.4m	15h32.4m
10°49'	−16°05'	−22°39'	−21°22'	−3°24'

The Planets in Their Orbits


Venus
Mercury
Mars
Earth
Jupiter
Earth
Mars
Pluto
Saturn
Uranus
Neptune

Mercury is in superior conjunction on May 31

Mars is at perihelion on May 17

Pluto is at opposition on May 11/12

Dots represent planets' positions at mid-month; arrows represent planets' motions from beginning to end of month.

POLAR ALIGNING YOUR TELESCOPE

Simple steps lead to perfect polar alignment
that will make both observing and photography a no-hassle joy.

by Michael Porcellino

Polar alignment gets a bad rap from beginners in astronomy. No one likes to think about it, let alone do it. But in fact it is a simple task that makes observing or photography under the stars far more enjoyable. As you look at a star, it moves across the sky from east to west in a giant curve. Any equatorial mounting can compensate easily for this movement, but for your telescope to follow a star in a smooth, continuous motion, you need to align its mounting with the celestial pole.

Luckily, polar alignment doesn't have to be any better than your needs demand. It's really a process of refining an initial approximation until the errors become too small to matter.

Most equatorial mountings are fitted with slow-motion controls in right ascension and declination that allow you to make small adjustments to the telescope's aim. Some beginners wonder why they can't simply twiddle these controls to keep an object centered. For a short spell of casual observing at low magnification this works all right, although it makes extended or high-power viewing awkward. But if you were taking photos, you would find that an unaligned mounting makes the field of view rotate slowly around whatever object you guide on. Stars would become curving lines instead of pinpoints, and if you wanted to use setting circles to locate an object, you'd find that the object wasn't where the circles say it should be. Since polar aligning doesn't take long to do, it's best to get in the habit of doing it right.

STARS CIRCLE POLARIS at the 1991 Texas Star Party. To compensate for this motion, you need to polar align your telescope's mount. Photo by Tom Polakis.

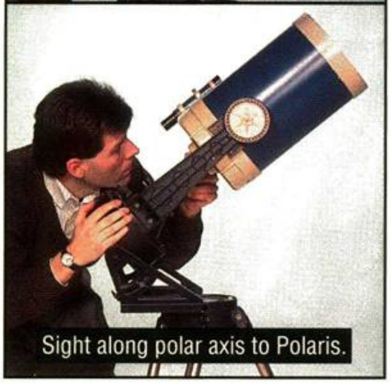
Two types of equatorial mounts are common, the fork mount usually supplied with Schmidt-Cassegrains and the German equatorial found on most other telescopes. The two types differ slightly in how you align them, mainly because the German equatorial does not allow the telescope to be pointed as easily straight at the pole.

First Things First

The first thing to do with any equatorial mount is to check that the polar axis and declination axis are perpendicular to each other. You can do this anytime. In fact, daytime is preferable because it will be easier to see what you are doing. First, turn the telescope until the declination setting circle reads +90° and clamp the declination axis. The telescope tube should now lie parallel to the polar axis. To check this, loosen the lock on the polar axis elevation and lower it until you can point the scope at a distant object on the horizon. Center the object in the field of view and rotate the tube in right ascension. The object you have aimed at should stay in place in the field of view and rotate around the center of the field.

SIMPLE ALIGNMENT.

Set declination to 90°.

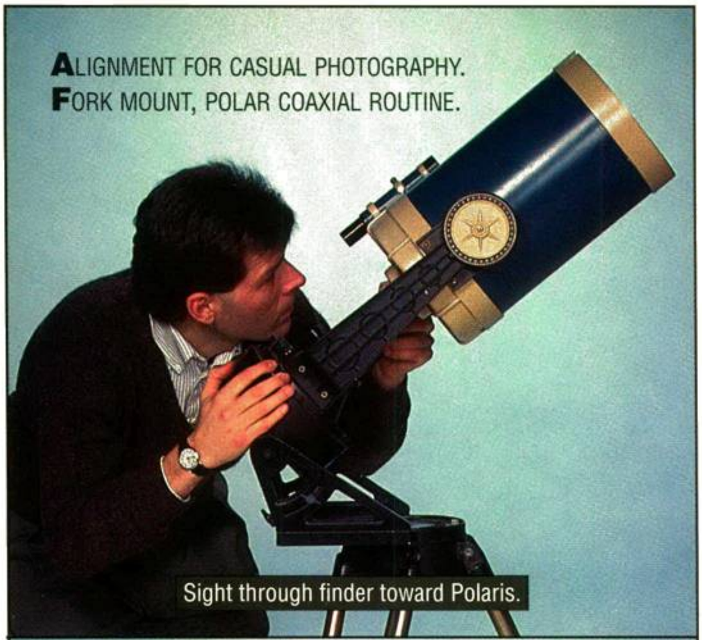


Sight along polar axis to Polaris.

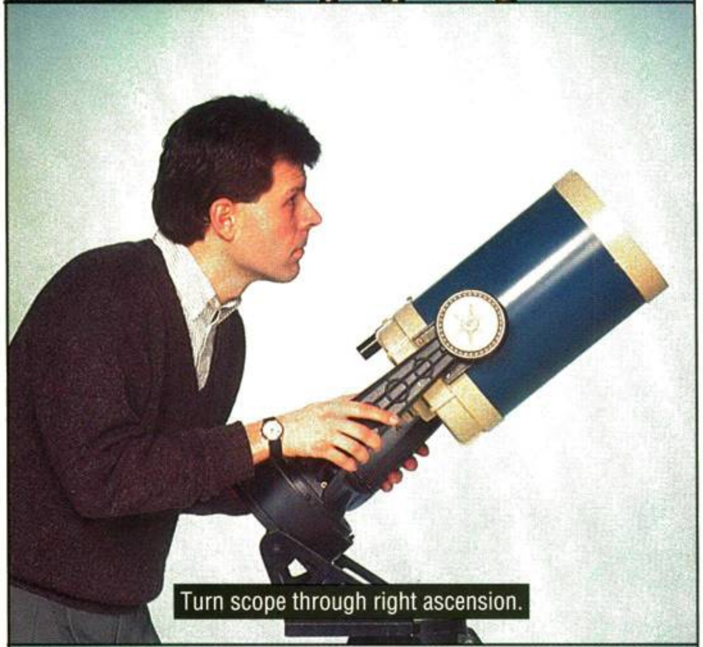
If it does not, the axes are not quite perpendicular and you will see the centered object rotate around some other point in the field of view. To correct this, you may have to give the declination axis a little turn from the 90° mark and try again. When the object stays put, adjust the declination circle to read 90°. If you can't get the object to remain stationary while turning the tube in right ascension, the telescope tube is not parallel to the polar axis. To remedy this you may have to shim the tube to make it parallel. Also take a moment or two to make sure that your finder is properly aligned. With a distant object in the telescope's eyepiece, adjust the finder's locking rings so the object lies dead center in the finder's crosshairs.

The next thing to do is to set the polar axis so it points at the pole. The elevation of the pole above the horizon is equal to the latitude of your observing location. Many equatorials have a scale that provides a coarse latitude setting directly. If your mount has it, use it. If your scope lacks this feature but does have setting circles, swing the tube in declination until the

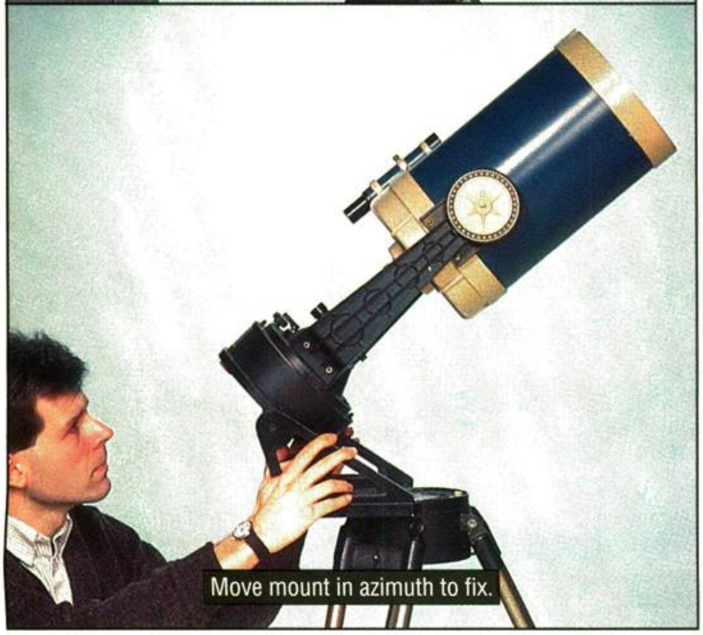
ALIGNMENT FOR CASUAL PHOTOGRAPHY. FORK MOUNT, POLAR COAXIAL ROUTINE.



Sight through finder toward Polaris.

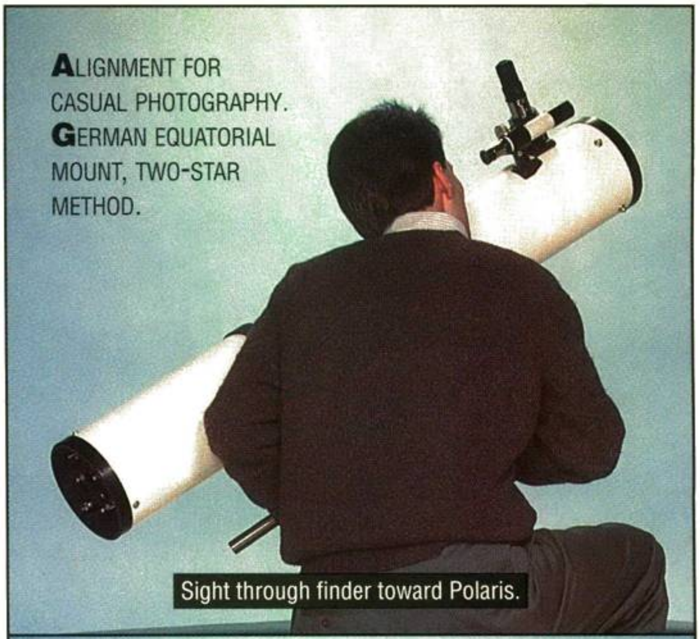


Turn scope through right ascension.

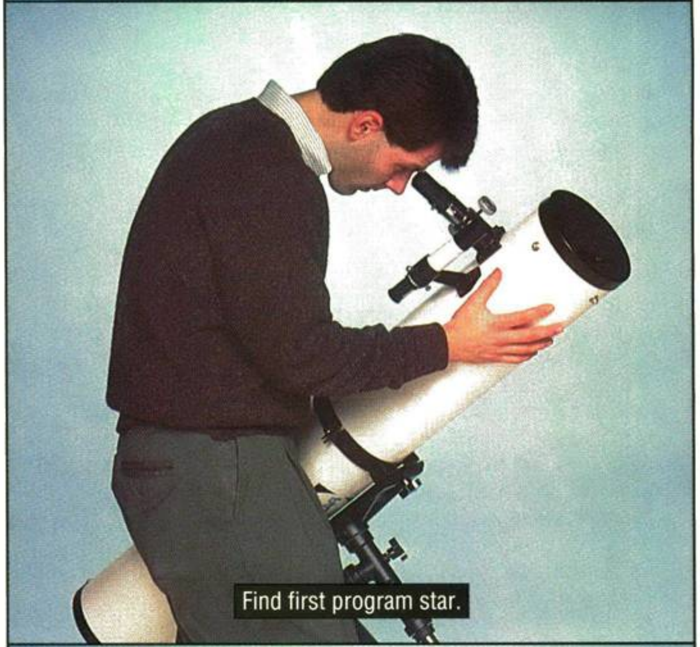


Move mount in azimuth to fix.

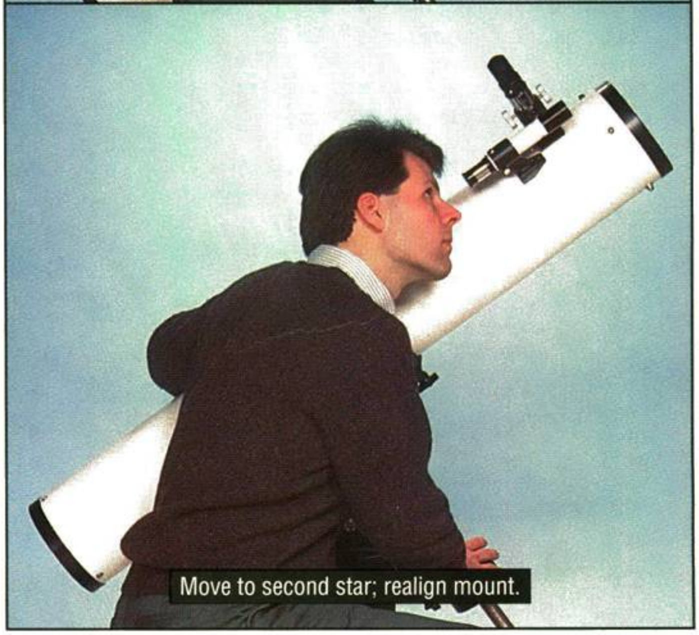
ALIGNMENT FOR CASUAL PHOTOGRAPHY. GERMAN EQUATORIAL MOUNT, TWO-STAR METHOD.



Sight through finder toward Polaris.



Find first program star.



Move to second star; realign mount.

declination circle reads your latitude (this is the declination of your zenith point). Clamp the axis. Now rotate the scope in right ascension until a carpenter's level shows the declination axis is horizontal. Lock the right ascension axis. Finally, adjust the mounting's latitude setting until the carpenter's level shows the tube is vertical. Now it's time to wait for sunset.

Method One: Simple Polar Alignment

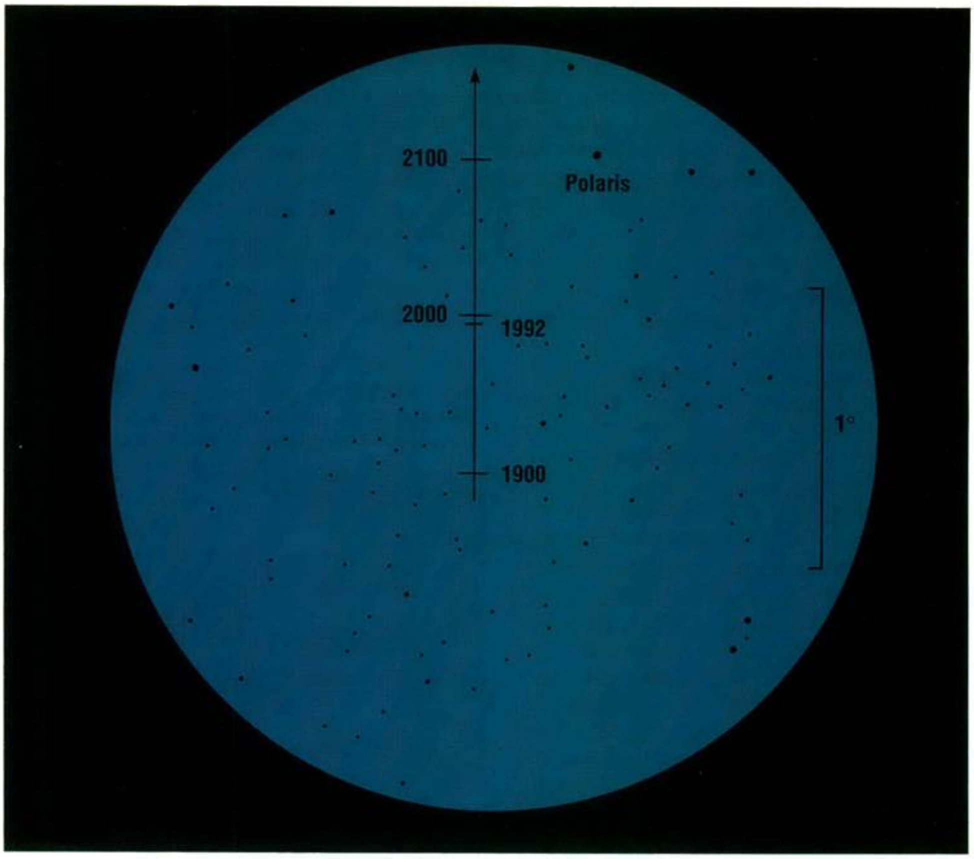
With the onset of evening and the return of Polaris to the sky, it's time to make a rough alignment on the pole. Squat down in front of the scope and aim the polar axis as best you can at Polaris. Eyeballing it like this puts the axis within 5° or so of the pole, good enough for casual viewing. You can improve the aim by swinging the scope until the declination circle reads 90°, then turning the whole mounting until you see Polaris in a low power eyepiece. This alignment provides relatively accurate tracking in right ascension with or without a clock drive.

Method Two: Alignment for Casual Photography

If you want to do photography through your telescope, even casually, you're going to need to align your scope more accurately. Here are two ways to get accurate alignment for photography. Each will align the scope to within 1° of the pole.

The fork mount found on most Schmidt-Cassegrain telescopes offers a relatively quick and easy method to obtain this more accurate alignment. Called polar coaxial alignment, this method uses the fact that the optical path of the telescope and the polar axis of the fork mount not only lie parallel but overlap. Point the scope to +90°, lock the declination axis, and observe through the finderscope. Now turn the whole telescope through right ascension and watch what happens. The image will rotate around the center of the finder's field of view. You need to turn the mounting left or right until the rotation point seen in the finder coincides with the celestial pole.

Although it is called the pole star, Polaris does not mark the exact pole, but rather is offset from it by 47'. To offset the correct amount in the right direction, align the scope with reference to Polaris and another easily found star, Gamma Cassiopeiae. As you can see from the diagram above, the position of the pole is continually moving (thanks to precession). At present, Polaris lies about 0.8° (47') from the pole, in roughly the same direction as Gamma Cassiopeiae, the star in the middle of Cassiopeia's W.



POLARIS DOES NOT MARK the exact north celestial pole, which is located some 47' away. This diagram shows the pole's apparent path over the years.

How far is 47'? Determine the field of view of your finderscope. If it has a field of view of 3.5° this equals 210'. The distance from the edge of the field to the center of the crosshairs would therefore be 105', and half of that distance is slightly more than 52'. So if you placed Polaris halfway between the center of the crosshair and the edge of the field (as offset toward Gamma Cassiopeiae), the celestial pole would lie close to the center of the crosshair. Check this position against the star field in the diagram above. Remember to make all your adjustments by moving the whole mounting, not the tube alone.

With a German Equatorial, you could follow the same process, but polar alignment is a lot more time consuming and difficult because the tripod or pier prevents you from rotating the tube completely freely in right ascension. Because it is awkward to point the scope directly at Polaris, the method often recommended for aligning a German Equatorial is the so-called "two-star" method.

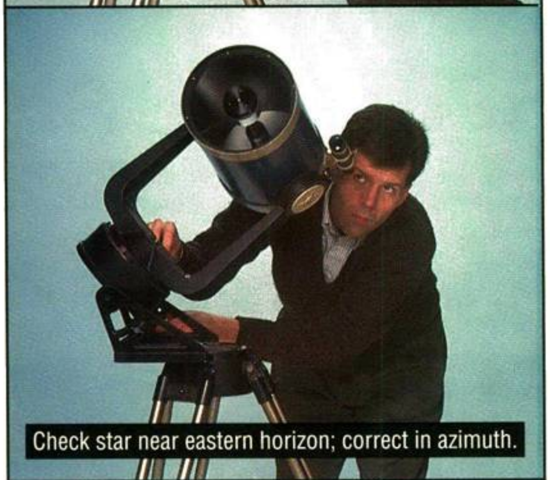
Once you've obtained rough alignment using the first method, locate two stars of either the same right ascension or declination, but separated by about 20°. Try the following pairs with the same right ascension: Lambda Orionis and Theta^1 Orionis; Iota Cancri and Epsilon Hydrae; Gamma Delphini and Lambda Cygni; and Mu Canis Majoris and Epsilon Canis Majoris. Center the first star in the finder or eyepiece and lock both axes. Then loosen the declination axis and swing the scope to the second star. It should move through the crosshairs in the finder or the center of the eyepiece. If it doesn't, adjust the mount slightly and try again.

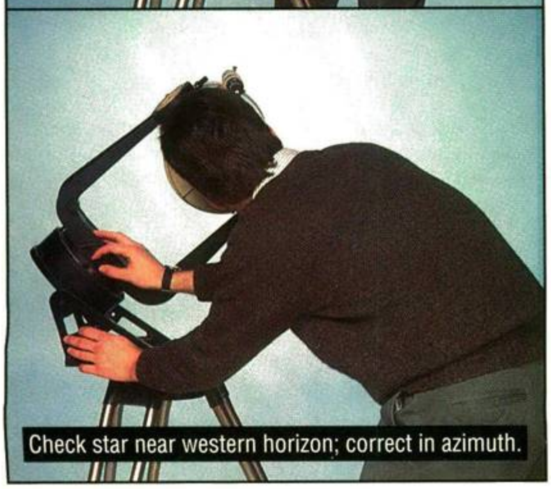
A variation of this involves using three stars, widely separated but lying within a degree or so of the celestial equator. Choose a trio of stars from the following group: Zeta Aquarii, Delta Orionis, Gamma Virginis, Lambda Ophiuchi, and Alpha Piscium. In this "three star" method, the telescope moves only in right ascension. Begin at the most western star of the three you have selected. Next, move to the second star; it should move through the center of the eyepiece. Then move to the third star, which should also move through the eyepiece. If the

Perfect polar alignment. Declination drift method.

Achieve rough alignment.

Select star near meridian, watch north-south drift.


Check star near eastern horizon; correct in azimuth.


Check star near western horizon; correct in azimuth.

telescope is not properly aligned, one or two of the stars will not move through the field of view. To remedy this, make a very slight adjustment in the azimuth of the telescope mount by turning it and try this procedure again. With a little luck, you should be quite close on the second iteration, close enough for everything but critical photography.

As a final check on the accuracy of this method, find a bright star and center it in the field of view. Look up the coordinates of this target and check your setting circles. The declination of the target should be within 3° of the listed declination. The right ascension of the star will have to be set on the right ascension dial. Next find another star and move the scope to that using the circles only. You should be able to "dial-in" the star's right ascension and declination, look into the eyepiece, and see it. If it's not there, it's back to square one — you're way off somewhere.

Method Three: Perfect Polar Alignment

When a scope is in perfect polar alignment, visual and photographic work becomes a snap. You can turn on your clock drive and track an object seemingly forever. To align your scope, first make the rough alignment as you did using the first method and refine it by using the second. This final method uses the declination drift of a star near the horizon or meridian to determine how far off the polar axis is and then correct it. If you are working with a refractor or a SCT and using a star diagonal, remove the star diagonal. Remember, star diagonals play havoc with directions in the field of view!

After you have made your rough alignment, select a star near the meridian (due south) and within 5° of the celestial equator. Center the star in your eyepiece and watch for its north-south drift. If you have a reticle eyepiece, align the crosshairs to their proper directions and watch to see if the star moves above or below the east-west crosshair. If you don't have a reticle eyepiece, place the star near the north or south edge of the field of view so you will be able to see any motion quickly. Pay no attention to the east-west drift of the star. Correct for this motion as needed with your right ascension control to keep the star in the field.

What you are looking for is north-south drift because it is entirely due to east-west misalignment of the polar axis. If the star drifts north, the polar axis is too far west. If the star drifts south, the polar axis is too far east. Make your correction by moving the mount in azimuth in the appropriate direction. Then start again, selecting another star near the meridian and equator and then recheck it. Repeat this procedure until you cannot detect any north-south drift.

Helpful Tools

- √ Polar alignment telescope
- √ Illuminated reticle eyepiece
- √ Latitude screw
- √ Azimuth adjustment screw

Now select a star rising near the eastern horizon. You'll probably need to go about 20° above the horizon to escape the turbulence and light pollution if you live in a city as I do. This star should also be no more than 5° from the celestial equator. Again, place the star in the field so you will be able to see any declination drift. You are again looking for north-south drift, but this time any drift you see will be caused entirely by the north-south misalignment of the polar axis. Now, if the star drifts north, the polar axis is too high and you'll have to lower it. If the star drifts south, the polar axis is too low. Make the necessary adjustments by adjusting the height of the polar axis and repeat the procedure until you cannot detect any north-south drift. This entire procedure takes about an hour but it is well worth the extra effort.

After you do a few trial runs at polar alignment, you'll find it comes quite naturally. You'll also see that it is a simple procedure that removes the fuss from your observing sessions. You'll be able to relax, soak in the stars, and enjoy the beauty of the universe with few guiding worries. ☐

Michael Porcellino is an avid amateur astronomer living in Chicago. His last article was "How to Collimate Your Telescope" in the April 1992 issue of ASTRONOMY.

In Pursuit of PLUTO

Only a few observers have ever seen the elusive outer planet. This year you can join their select club.

by Richard Talcott

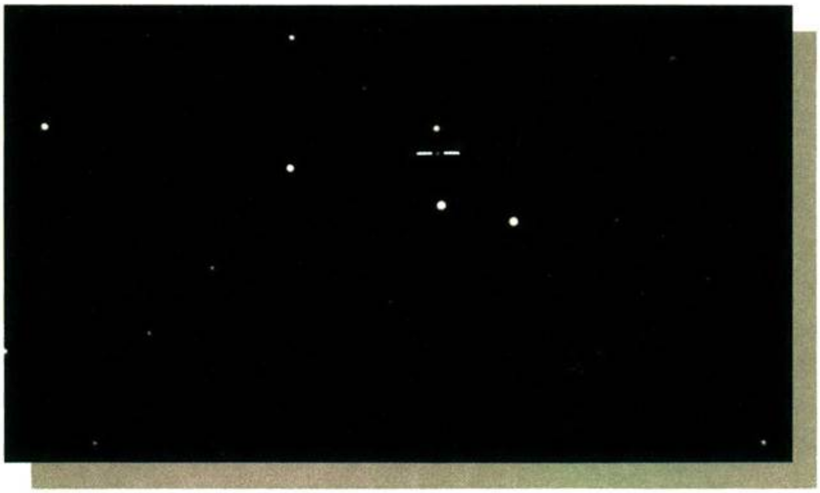
The mere mention of the planet Pluto evokes vivid yet surprisingly different images in the minds of backyard astronomers. On the one hand are images of a young astronomer named Clyde Tombaugh, diligently poring over stacks of photographic plates, searching for a solitary point of light that changed position — and finding it. On the other hand are images of a stark, frozen wasteland feebly illuminated by the distant Sun.

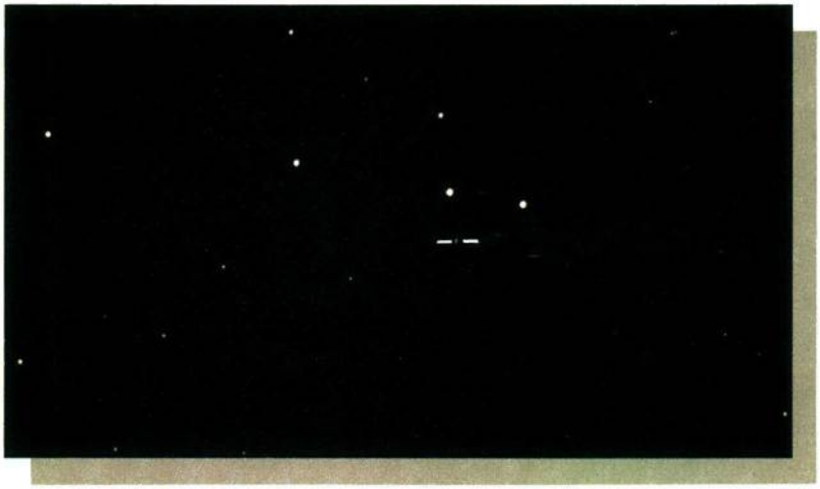
Yet the images are somewhat misleading. You don't need the patience of Job (or Clyde Tombaugh) and access to a professional observatory's telescope to see Pluto today. And though the planet may not be warmed significantly by the faraway Sun, enough sunlight reflects off its surface that many Earthbound observers can spot Pluto in their backyard telescopes.

Viewing Pluto is a challenge, to be sure. But if you use a good-quality, 8-inch or larger telescope, choose a dark observing site, and know exactly where and when to look, you can see this enigmatic world with your own eyes. The finder charts presented on these pages will guide you to Pluto's location. All you need to supply are the telescope, the observing site, and a few nights of your time.

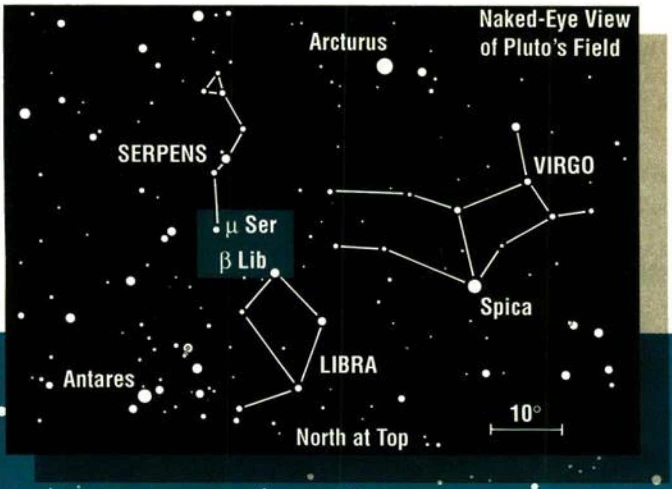
Fortunately, this spring and summer are excellent seasons to pursue Pluto. First, Pluto is now nearly as bright as it ever gets. (For several months surrounding its opposition on May 11/12, the planet glows at a peak magnitude of 13.7.) That's because Pluto is still relatively close to Earth and thus reflects more of the Sun's light in our direction. Our two worlds were closest to one another just two years ago, and the distant planet moves so slowly in its 248-year orbit around the Sun that it is not much farther away now.

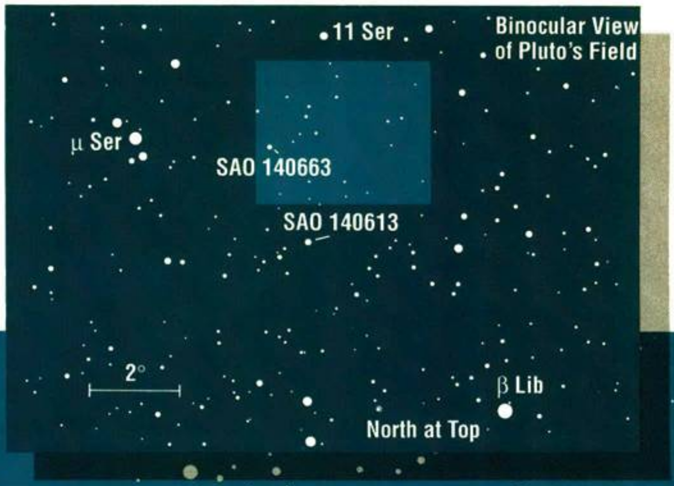
Second, Pluto currently is traversing a rather barren area of the sky. Few stars brighter than Pluto lie along the Libra-Serpens Caput border, so it is fairly easy to pick out Pluto from the stellar background.





A SUBTLE SHIFT in position relative to the background stars of Virgo is all that belies the presence of Pluto in Martin Germano's photographs from April 2 and 4, 1983.


Naked-Eye View of Pluto's Field
Arcturus
SERPENS
VIRGO
μ Ser
β Lib
Spica
Antares
LIBRA
North at Top
10°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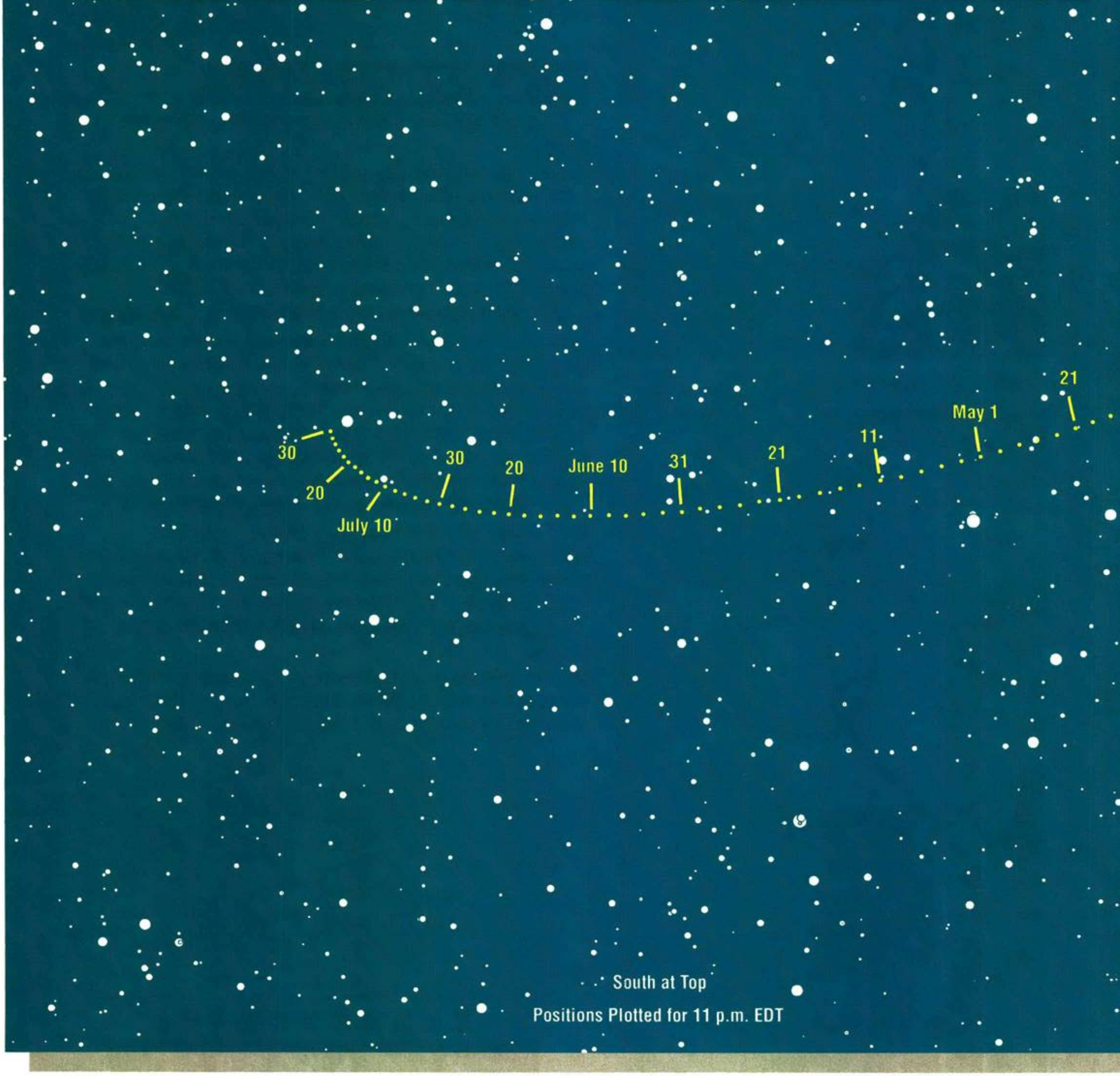
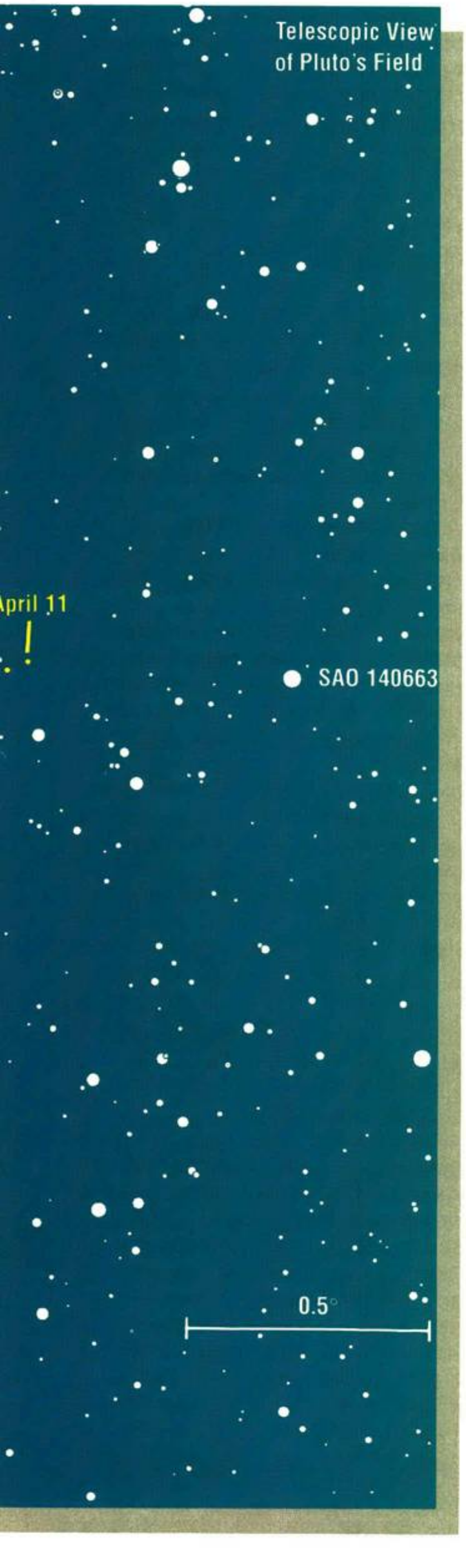
Binocular View of Pluto's Field
μ Ser
SAO 140663
SAO 140613
2°
β Lib
North at Top


21
May 1
11
21
31
June 10
20
30
July 10
20
30
South at Top

Positions Plotted for 11 p.m. EDT



That situation will change over the next decade, however. By the year 2000, Pluto will edge into the fringes of the Milky Way in Ophiuchus, making the job of identifying the planet much more difficult.

Getting Ready

To take advantage of Pluto's brightness and prime position, you'll want to use an 8-inch or larger telescope. A few people have glimpsed Pluto in 6-inch telescopes, but only on exceptionally dark and clear nights. (Though Pluto is relatively bright this year, the key word is *relative*. At magnitude 13.7, the planet is about 1,000 times too faint to be seen without a telescope.) Compared with a 6-inch telescope, an 8-inch scope collects over 75 percent more light, a 10-inch scope pulls in more than two and a half times as much light, and a 12-inch scope gathers four times as much light. When you're searching for Pluto, every photon counts.

You should also be sure that your telescope is in top working condition. If you haven't cleaned or collimated your scope in a long time, the opportunity to gaze on Pluto gives you a good reason. (See "How to Clean Your Optics" and "How to Collimate Your Telescope" by Michael Porcellino in the March and April issues, respectively.)

Next, find an observing site that is as far away from city lights as possible. Even a little bit of scattered light can drown out the light from distant Pluto. High humidity also adds to scattered light so if you can, avoid sites near major rivers, large lakes, or the ocean. Good seeing conditions are important as well. You'll get steadier eyepiece views if your telescope looks out over a large expanse of grass and worse views if you're forced to observe over an asphalt parking lot, concrete buildings, or even the roofs of your neighbors' houses — anything that absorbs the Sun's heat during the day and gives it off again at night.

Just as scattered light from a nearby town can drown out your view of Pluto, so can the natural illumination provided by the Moon. The best times to hunt down the elusive ninth planet are when the Moon is out of the sky. Your first opportunity is in late April and early May. New Moon comes on May 2, so the sky will be dark from the last few days of April through the first week in May. The next observing window covers the last five days of May and the first five days of June, with New Moon on the night of May 31/June 1. New Moon rolls around again on June 30, bringing with it dark skies from about June 25 to July 5. And in July, New Moon comes on the 29th, so dark skies will prevail for the last week of that month and the first few days of August.

What you want to do next is wait for a night of clear weather during one of the Moon-free periods listed. When that night comes, load up your telescope and head out to your observing site. Plan on arriving no later than sunset so you can set up your telescope before it gets dark. Setting up your scope early gives it time to cool to the ambient air temperature, which will provide you with steadier images. In the hour or more it takes for the scope to reach thermal equilibrium, you can view the sights of the late spring and summer sky while your eyes become dark-adapted.

Now you're ready to go. The maps at left will help you find Pluto on any day between mid-April and the end of July. The technique is quite simple: star-hop from a group of bright naked-eye stars to stars easier to see in binoculars or a finderscope, and from there go into a telescopic field of view containing Pluto. Then center that field in a medium-power eyepiece and you should be able to see the planet.

Chasing the Quarry

The search begins with the bright star Arcturus in the constellation Bootes. This star is easy to find — simply follow the curve of the Big Dipper's handle outward about 30°. Arcturus is unmistakable — it's the brightest star in the spring sky at magnitude 0.0 and appears orangish to the naked eye. After arcing to Arcturus, speed on another 20° or so until you reach the luminary of Virgo, the 1st-magnitude star Spica. (A convenient way to measure angular distance in the sky is to make a closed fist and hold it at arm's length. The angle spanned by your fist is then about 8° to 10°.)

Now shift your gaze about 25° due east of Spica, to Libra's brightest star, 3rd-magnitude Beta Librae (ß Lib). Beta and the 3.5-magnitude star Mu Serpentis (μ Ser), which is located some 10° to the northeast of Beta, are the two key jumping-off points to reaching the faint stars in Pluto's vicinity.

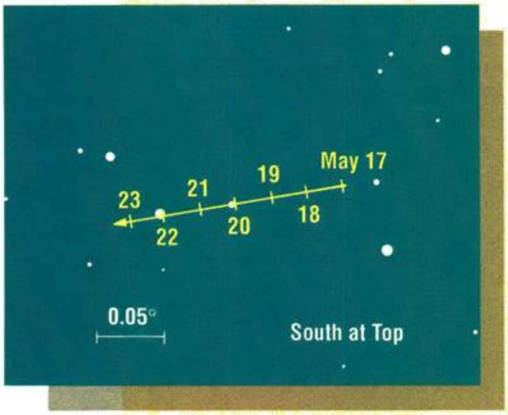
Now it's time to pull out the binoculars. You need to locate the 8th-magnitude star SAO 140663 that is located about 3° due west of Mu

A Rare Occultation

The night of May 20/21 brings with it a rare and potentially very exciting event — the occultation of a 14th-magnitude star by Pluto and perhaps its satellite Charon. The light of the distant star will be blocked from view as Pluto casts a shadow all the way to Earth, over 2.6 billion miles away.

The event is timed perfectly for North American observers, though the Moon is a waning gibbous that night. Current predictions say the middle of the Pluto occultation will occur at 2:17 a.m. EDT (1:17 a.m. CDT, 12:17 a.m. MDT, and 11:17 p.m. PDT) while that for Charon will come one minute earlier, though the times could be off by a minute or two. At those times Pluto is above the horizon for the entire Western Hemisphere. The only question is whether the occultation will be visible from North or South America. Astronomers do not know the orbit of Pluto precisely enough to pinpoint where on Earth Pluto's shadow will fall.

If you watch this event, you'll see Pluto slowly creep up on the star (the diagram below shows Pluto's position at 11 p.m. EDT over a seven-day span.) The two will appear to merge in your eyepiece well before the occultation begins because the seeing broadens the images of both objects. At the time of the occultation, the combined light of the two will drop by a third.



You can observe the event for the fun of it, or you can help astronomers refine their knowledge of the Pluto-Charon system by accurately timing the occultation. If you choose to do the latter, at least a few nights before the 20th, identify the field of the soon-to-be-occulted star using the finder chart below, which shows south at top.

On the night of May 20/21, set up your telescope ahead of time to let it reach thermal equilibrium. Bring along a small audio tape recorder and a radio capable of receiving WWV or WWVH, which broadcast the accurate time at frequencies of 2.5 MHz, 5 MHz, 10 MHz, 15MHz, and 20 MHz. In eastern Canada, radio station CHU also broadcasts accurate time at 7.335 MHz and 14.67 MHz. Don't rely on local radio stations or the phone company for the time — they can be off by several seconds.

Around the time of the occultation, let the tape recorder run and the radio play in the background while you watch the star continuously. When it disappears and reappears, shout the event into the recorder. Also, don't forget that both Pluto and Charon may occult the star, so be prepared for up to four events. When you replay the tape, you can determine the time of the occultation to within about a quarter of a second. (Take into account your reaction time, which is typically between 0.2 and 0.5 second.) Also record the time you started and stopped looking at the star.

Write down the precise latitude, longitude, and altitude of your observing site, the type of telescope, the eyepiece power, and the local weather conditions, including the seeing and sky transparency. You can get a standard report form from the International Occultation Timing Association at 1177 SW Collins Avenue, Topeka, KS 66604-1524. Reports of your observations can be sent to IOTA in care of Jim Stamm, 11781 North Joi Drive, Tucson, AZ 85737. — *Peter Manly*

Serpentis. Pluto lies just 0.5° west of this star in mid-April.

Though Pluto moves away from SAO 140663 after April, several other stars in the vicinity serve as guide stars, and they are only slightly fainter. You can find these on the telescopic finder chart, which shows stars down to magnitude 14.5. (On this chart, south is at top to match the view in an inverting telescope.)

To use the telescopic finder, locate Pluto's position on the chart for the day you're observing. (The positions are given for 11 p.m. EDT, 10 p.m. CDT, 9 p.m. MDT, and 8 p.m. PDT. Pluto moves so slowly, however, that the positions shown are close for the entire night.) Then star-hop to that region by gently moving your telescope from one reasonably bright star to the next.

Is That Dot Really Pluto?

Once you've located the correct field, center Pluto's position in a low-power eyepiece. Then increase the power to about 10x per inch of aperture. You should be able to tell which of the pinpoints of light is actually Pluto by comparing the finder chart with your view in the eyepiece. But if the field is a bit too crowded or you're just a little bit unsure, you need to confirm your sighting.

To do this, you have to detect Pluto's motion relative to the background stars. (The stars themselves are so distant that they appear stationary.) Make an accurate sketch of the field of view, concentrating particularly on the stars near what you think is Pluto and on the stars shining at about the same brightness as Pluto. If you're an astrophotographer, you can photograph the star field instead. Then return a night or two later and compare your sketch with the current field of view. If you were right about Pluto, it will have changed position slightly. If you were wrong, that star will be stationary but another one in the field of view will have moved a bit, revealing its identity as Pluto.

What you see is a far cry from the otherworldly landscapes you may have envisioned. After all, that point of light you're looking at is the smallest planet in the solar system and you're viewing it from a distance of more than 2.6 billion miles. But use your imagination and that faint glimmer of light magically transforms into a real word — a frigid world of rock and ice slowly circling the distant Sun in a deep and permanent twilight. □

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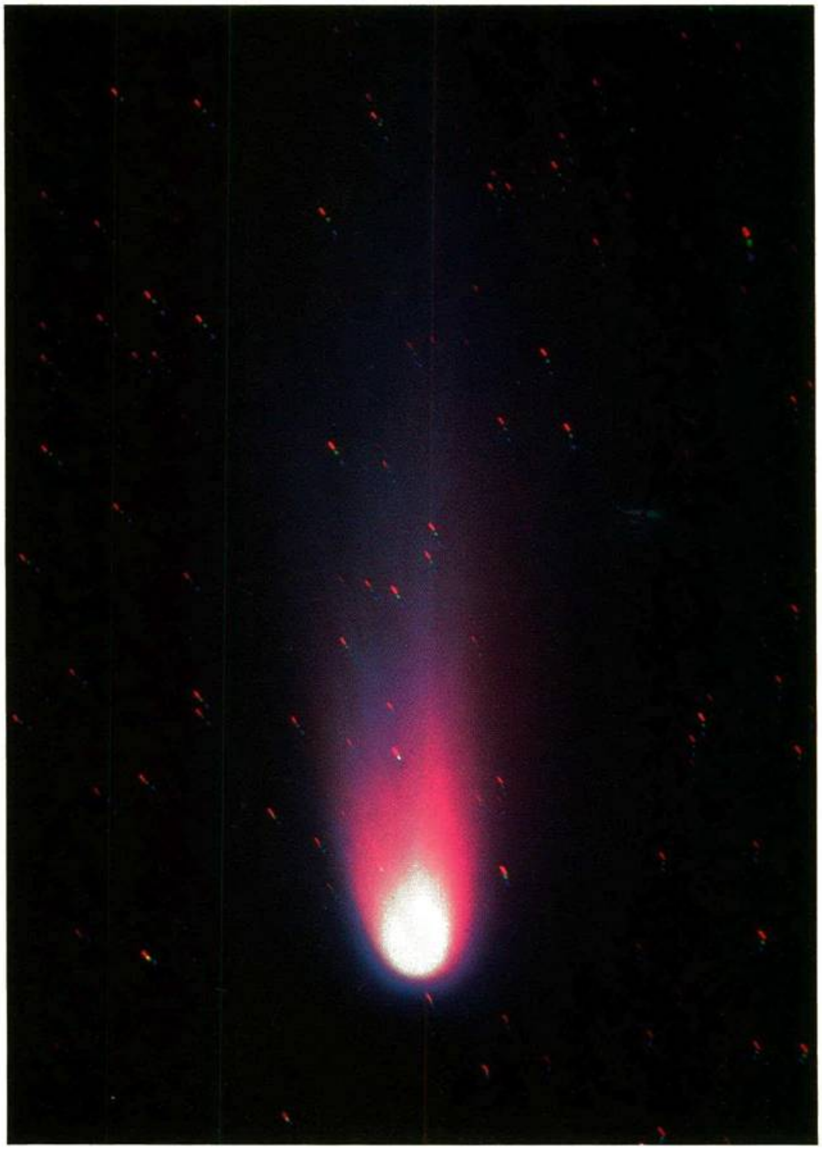
WATCHING HALLEY'S DEBRIS

And you thought Halley's Comet was visible only every 76 years. Not so.

by Philip M. Bagnall



FLOWING FROM THE NUCLEUS of Comet Halley is a dusty tail that spreads debris around the comet's orbit. Halley's dusty wake produces two annual showers of meteors, including one visible this month. European Southern Observatory photo.

You may have watched Halley's Comet hurtle away from the Sun in 1986 and thought you had seen the last of it, at least until 2061. But twice a year, every year, debris cast from that most famous of comets rains down on Earth. The debris is simply specks of comet dust — the same type of dust that spewed from the vaporizing nucleus of Comet Halley, peppering the Soviet and European comet probes and contributing to the characteristic tail of the comet.

This cast-off dust spreads along the comet's path and can remain in orbit about the Sun for thousands of years. When Earth collides with the ancient dust stream, the particles enter Earth's atmosphere at high speed. Each particle burns up in a brief flash of light — a meteor, more popularly (but mistakenly) called a "shooting star."

The result of Earth's semiannual passages through Halley's dust stream is a pair of annual meteor showers, nights of heightened meteor activity. Each May we are treated to the Eta Aquarid shower; each October we get the Orionids. At the peak of each shower, you should be able to see 20 to 25 meteors streak across the sky each hour, provided you are watching from a dark rural location.

Normally, other meteor showers such as the Perseids of August and Geminids of December put on the best shows of the year, but this year both these active showers are beset by a nearly Full Moon. Its light will wash out all but the brightest meteors. Out of the half dozen top-rated meteor showers this year, only the two created by Comet Halley enjoy dark Moon-free skies — they promise to provide the year's best meteor shows.

First Encounter: The Eta Aquarids

Your first chance this year to observe Halley's dust burning up in the atmosphere occurs this May. Between April 21 and May 20, our planet passes through the Halley dust stream for the first time in 1992. The name of the shower, the Eta Aquarids, comes from the fact that the meteors appear to streak out of the constellation Aquarius, a star pattern that for Northern Hemisphere observers at this time of year lies low in the southeastern sky during the morning hours. A precise plot of the meteor paths reveals that the source point lies near the star Eta (η) Aquarii.

In reality, the meteoroids (as the

METEOR WATCHING CHECKLIST

- ☐ Dark sky location
- ☐ Warm clothing
- ☐ Lawn chair
- ☐ Warm drink (and food!)
- ☐ Radio or cassette player (for music)
- ☐ Binoculars (for rare, long-lasting meteor trails)

OPTIONAL

- ☐ Star charts for plotting meteor paths
- ☐ Notebook for recording meteor magnitudes, colors, times
- ☐ WWV time code receiver

METEORS
METEOR SHOWERS

YOU DON'T NEED MUCH TO SEE METEORS. But making notes and plotting meteor paths can make any meteor watch more memorable. At right, a pair of Eta Aquarid meteors, particles that were once part of Comet Halley, streaks across Australian skies. Photo by M. L. Clark.

dust particles are properly called when they are still out in space) enter our atmosphere with nearly parallel trajectories. They appear to converge to a point in the sky in much the same way that the parallel lines of a railway track seem to converge to a point on the horizon. Meteor watchers call this point the radiant.

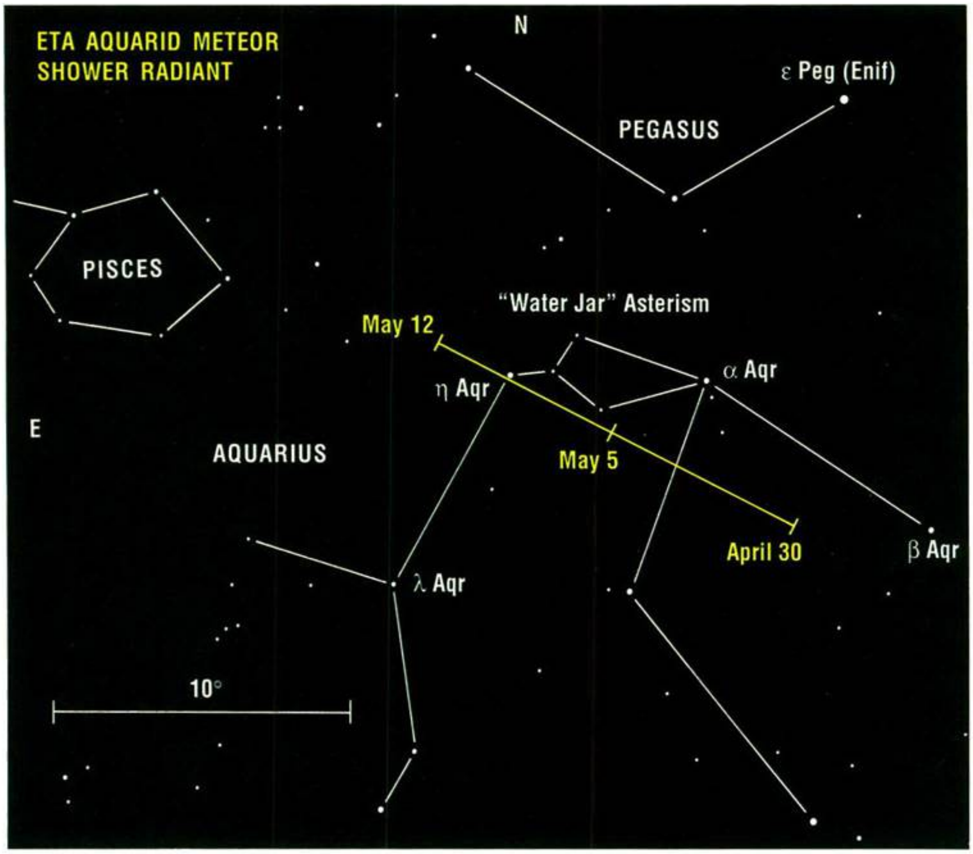
The radiant of the Eta Aquarids lies at a right ascension of about 22h20m and a declination of –1.9°. (Lines of right ascension and declination are marked on most star maps to aid in plotting objects.) The radiant point is not fixed, however. It can vary slightly from year to year. The radiant also drifts across the sky from night to night, the result of Earth's moving through the stream. This drift amounts to a nightly shift of +0h4m in RA and +0.4° in Dec.

Circumstances for this year's display of the Eta Aquarids are as good as they get. Maximum activity occurs around May 4. On that date the Moon is only two days old and will not interfere with observations. A moonless sky is essential for the Eta Aquarids — their average magnitude is only about 3, though the brighter meteors are noted for their persistent trains. Eta Aquarid meteors also move very quickly. With entry velocities of 66 kilometers per second (148,500 miles per hour) they are among the swiftest shower meteors visible, second only to November's Leonids.

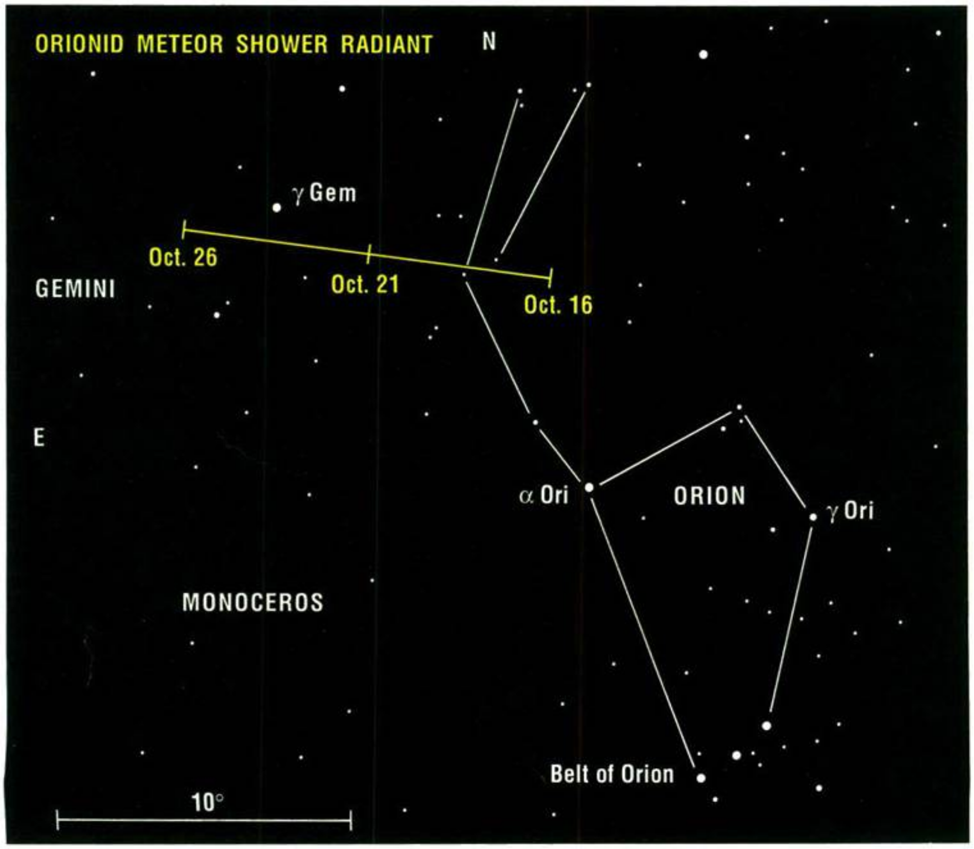
For North American observers, the best time to look will be during the early morning hours of May 4. However, Eta Aquarid activity lasts for several days — don't expect the sharp activity peak displayed by the Quadrantids or Geminids. The broad peak means you'll see shower meteors on the mornings of May 3 and 5.

No matter which date you pick, you'll need to plan your meteor watch for the predawn hours. For mid-latitude northern observers, the radiant point in Aquarius doesn't rise above the eastern horizon until about 2:30 a.m. local time, making the optimum observing window the period from "radiant-rise" to sunrise. During that time, the radiant point will be in the southeastern sky.

The number of meteors you'll see will depend on your latitude. The southerly declination of the Eta Aquarid radiant makes this an excellent meteor shower for backyard astronomers in the Southern Hemisphere. In fact much of what we know about this shower has



THE RADIANT OF A SHOWER moves across the sky from night to night. Near the peak of the Eta Aquarids May 4/5, the radiant lies near the Water Jar asterism in Aquarius. During the Orionids in October, the radiant traverses Orion.



come from observers in South Africa and Australia.

For observers in the Northern Hemisphere, the farther south you live, the higher the radiant appears above the southeastern horizon, and the more meteors you will see. You should be at least as far south as the latitude of Minneapolis (45° N). Anyone farther north than this — say in Maine, northern Wisconsin and Minnesota, North Dakota, Montana, northern Idaho, Washington, Canada, and northern Europe — will find the radiant low on the eastern horizon. By the time it starts to climb to a reasonable altitude, morning twilight interferes with observing. Nevertheless, northern observers should still be able to see 10 to 15 meteors an hour.

Second Encounter: The Orionids

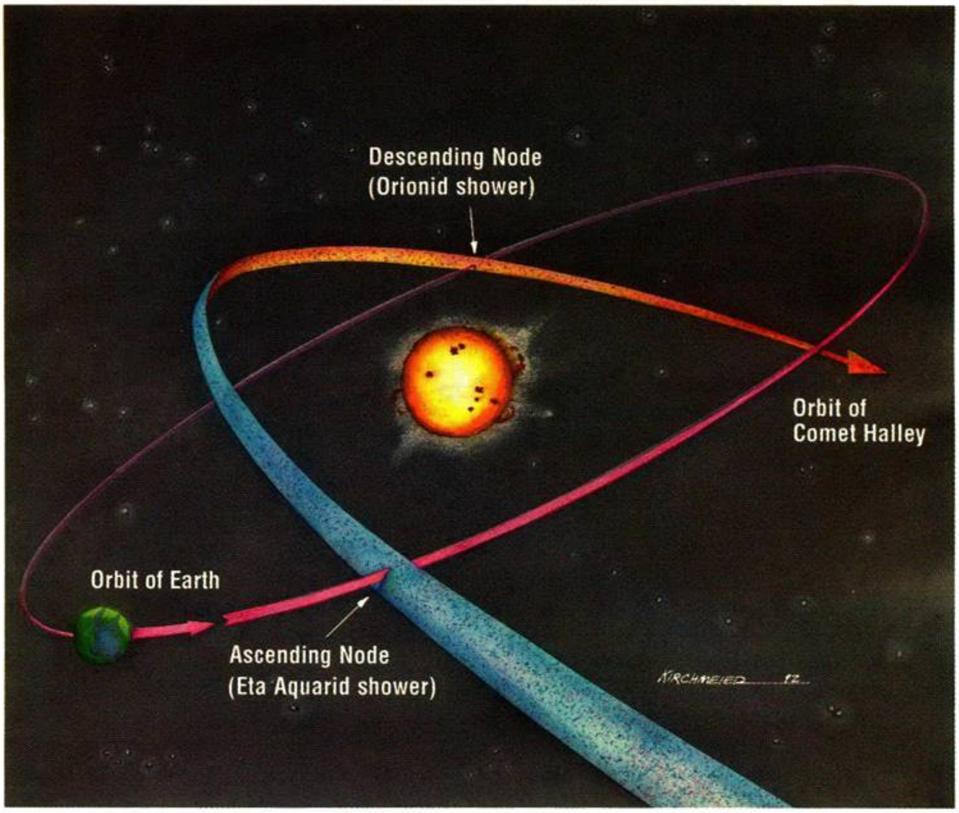
If you miss the spring display, you need only wait until the autumn for a second chance to observe Halley's debris. This time the radiant is farther north at a declination of +15° and right ascension of 6h24m, a spot near Orion's upraised right arm (*his* right, our left). We call this shower, not surprisingly, the Orionids. Activity commences on about October 15 and runs to about October 29 with maximum around October 21. The radiant drifts by 0h5m in RA and +0.13° in Dec. per night.

The physical characteristics are the same as for the Eta Aquarids — fast, faint meteors with a broad peak lasting several days. On October 21 this year, the Moon will be 25 days old, just a few days before New. Under clear dark skies, expect to see about 25 meteors per hour. With the Moon out of the way, the Orionids promise to be the best shower of the last half of 1992.

Dust in the Wind

You may be wondering how one comet can produce two meteor showers. The six-month gap between the two provides a clue. The complete answer comes from an understanding of just what a meteoroid stream is.

For most of its life, a comet remains far from the Sun and exists as a frozen chunk of ice a few miles across. But when a comet approaches the Sun, the heat gradually warms the comet's surface. But the frozen nucleus begins to erupt with activity. The ices begin to vaporize and form a cloud of gas around the solid nucleus. When this happens, the comet appears from Earth as a fuzzy "star." If it gets warm enough,



ASTRONOMY: Illustrations and diagrams by Phil Kirchmeier

SLICING ACROSS EARTH'S ORBIT is the elongated path of the debris left by Comet Halley. The meteoric material collides with Earth twice a year — in May as it travels north and in October as it travels south. The result is the Eta Aquarid and Orionid meteor showers.

the comet may develop a long tail flowing from the nucleus in a direction away from the Sun.

This vigorous release of gas takes with it trapped dust particles that begin to orbit the Sun independently of the nucleus. This is the first step in the birth of a meteoroid stream.

As the millennia pass, the cometary dust spreads around the entire orbit of the comet and also spreads outward, away from the dense core. This diffusion is caused principally by two forces. The first is gravity.

All objects in the solar system are subjected to gravitational forces. Meteoroid streams lying in the general plane of the solar system are exposed to far stronger, more complex gravitational forces than streams lying in high inclination orbits. Consequently, they have relatively short life spans.

Comet Halley, however, doesn't travel in the same plane as the planets. Its orbit intersects the plane of the solar system at a high angle, coming in from below, cutting above the solar system plane near the Sun, and then heading back south below the orbits of the planets. Its debris is less subject to gravitational disturbances.

The second force acting on comet dust is called the Poynting-Robertson effect. The effect occurs because each dust particle absorbs solar radiation on its sunlit side. It then re-radiates this energy from its entire surface, both the sunlit and dark sides. The uneven absorption and re-radiation of energy gives the particle a kick outward. But the particle moves too slowly for its new orbit and it begins to spiral toward the Sun. (In reality, the Poynting-Robertson effect acts on all objects in the solar system. However, for moon- and planet-sized worlds, the effect is negligible. But for meteoroids less than one millimeter across, it's a significant force.)

The combination of these two forces disperses fragile meteoroid streams. The meteoroids spread across the inner solar system to become part of the diffuse cloud that produces the zodiacal light, a soft glow often seen above the horizon after the end of evening twilight or before the onset of morning twilight.

For a meteoroid stream to survive it must be replenished at regular intervals. In the case of Comet Halley, that interval is every 76 years. However, the dust we encounter now probably left Comet Halley hundreds of years ago, during its passages by Earth in medieval times. It will be many more generations before people see the traces of dust left by Comet Halley during its 1986 visit.

Twin Passages

The stream of meteoroids laid down by Comet Halley passes within 52 million miles of the Sun (halfway from Earth to the Sun). It reaches out to beyond 1,400 million miles, equivalent to a distance halfway between the orbits of Saturn and Uranus. All of the meteoroids pass through the perihelion point (the point closest to the Sun), where the stream is quite narrow, but spread out into a wide band at aphelion (the farthest point from the Sun). Like Comet Halley itself, the particles travel around the Sun backward (compared with the direction the planets travel) and are in orbits angled steeply to the plane of the solar system, or ecliptic.

The angled orbit of the meteoroids intersects Earth's orbit at two points. The first is where the particles cross our orbit headed north from below the ecliptic plane. This intersection point is called the ascending node. Since the particles are traveling from south to north, the meteors collide with Earth's Southern Hemisphere. This is why the Eta Aquarids are best seen from southern locations.

Half a year later, Earth is on the other side of its orbit and passes through the stream again, this time at the descending node. The meteoroids are traveling from north to south and the shower appears in the Northern Hemisphere's sky.

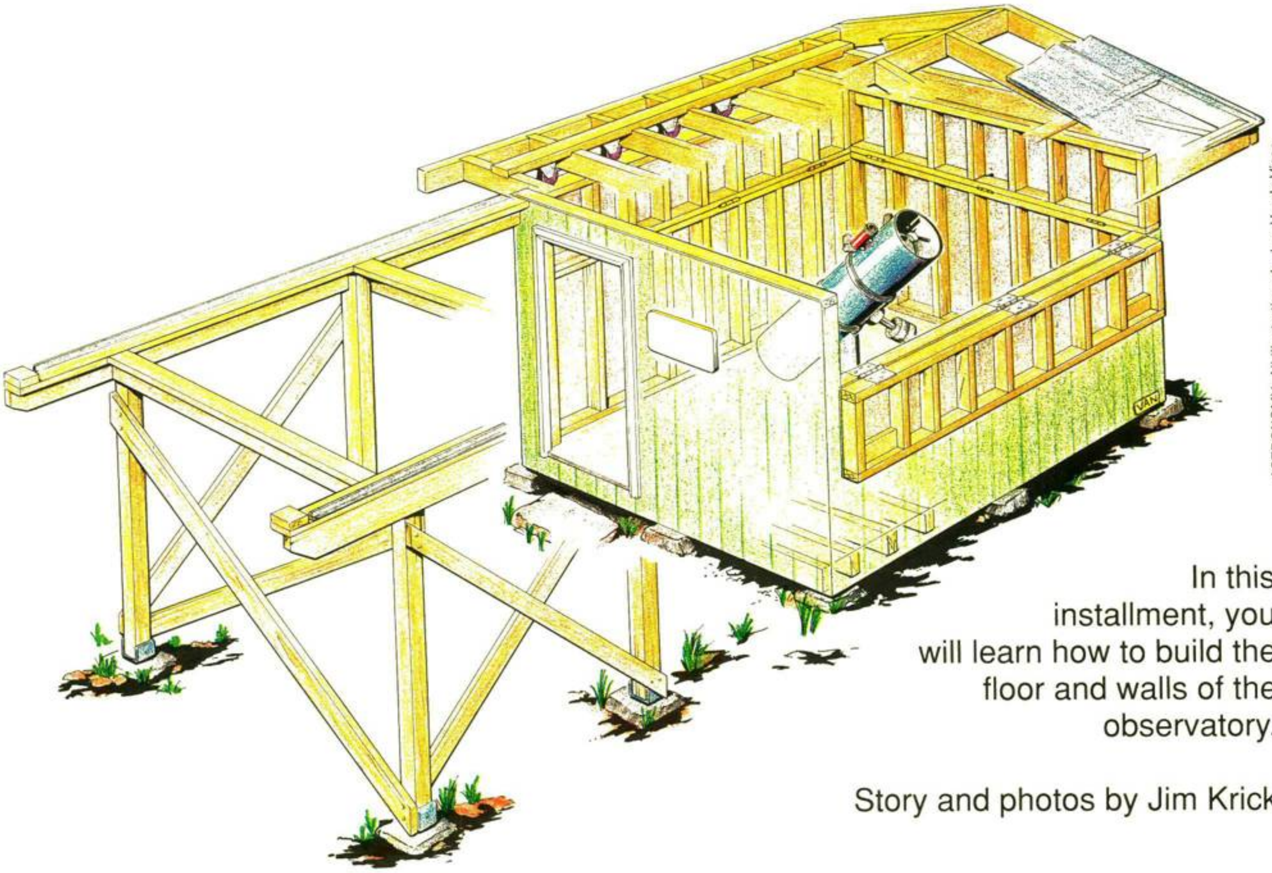
With most meteor streams produced by other comets, Earth intersects the stream at only one of the two nodes. But with the Halley meteoroids, Earth passes through *both* nodes: first in the spring, then in the fall. Though seeing the parent comet is normally a once-in-a-lifetime chance — a chance that for most of us has now gone — the quirks of orbital geometry give all of us two chances every year to see a legacy of Comet Halley. And this year is one of the best for catching both of Halley's showers. ☐

Philip M. Bagnall is president of the Society of Meteoritophiles and has profiled a number of meteor showers for ASTRONOMY including the Geminids (December 1990), the Perseids (August 1988), and the Quadrantids (January 1987).

3 PART SERIES

PART 2

Building Owl Observatory



ASTRONOMY: All illustrations by Lee Vande Visse

In this installment, you will learn how to build the floor and walls of the observatory.

Story and photos by Jim Krick

As described in part one of this series, Owl Observatory is a 10' x 10' building located about 25 miles east of Great Falls, Montana, near the small community of Highwood. Because I wanted access to the entire sky for astrophotography, my observatory has a roll-off roof rather than a dome. But I also wanted access to objects near the horizon, so the upper two feet of the walls of the observatory fold down. The elevated wooden floor prevents animals from nesting under the building and is warmer than concrete during the cold winter months.

I used only powered hand tools — a saw, a small miter saw, a scroll saw, a couple of drills, and a borrowed router — to build the observatory. A borrowed generator powered these tools at the work site. The entire cost of the structure was $1,500.

Part 1 described how I built the steel pier for the telescope and its concrete footing. It also described how to lay out the foundation for the building and roof supports and how to pour the concrete footings. Because this phase of the construction ended as winter approached, I had to stop construction at the site. But work didn't stop. I prefabricated the walls and roof in my garage.

PREFABRICATING THE WALLS in my garage during the winter made construction go faster and easier. The studs were secured to the top and bottom wall plates with 3" screws.

In this installment, I'll tell you how to build the floor and walls and erect the walls on site. First we'll look at the floor construction.

Building the Floor

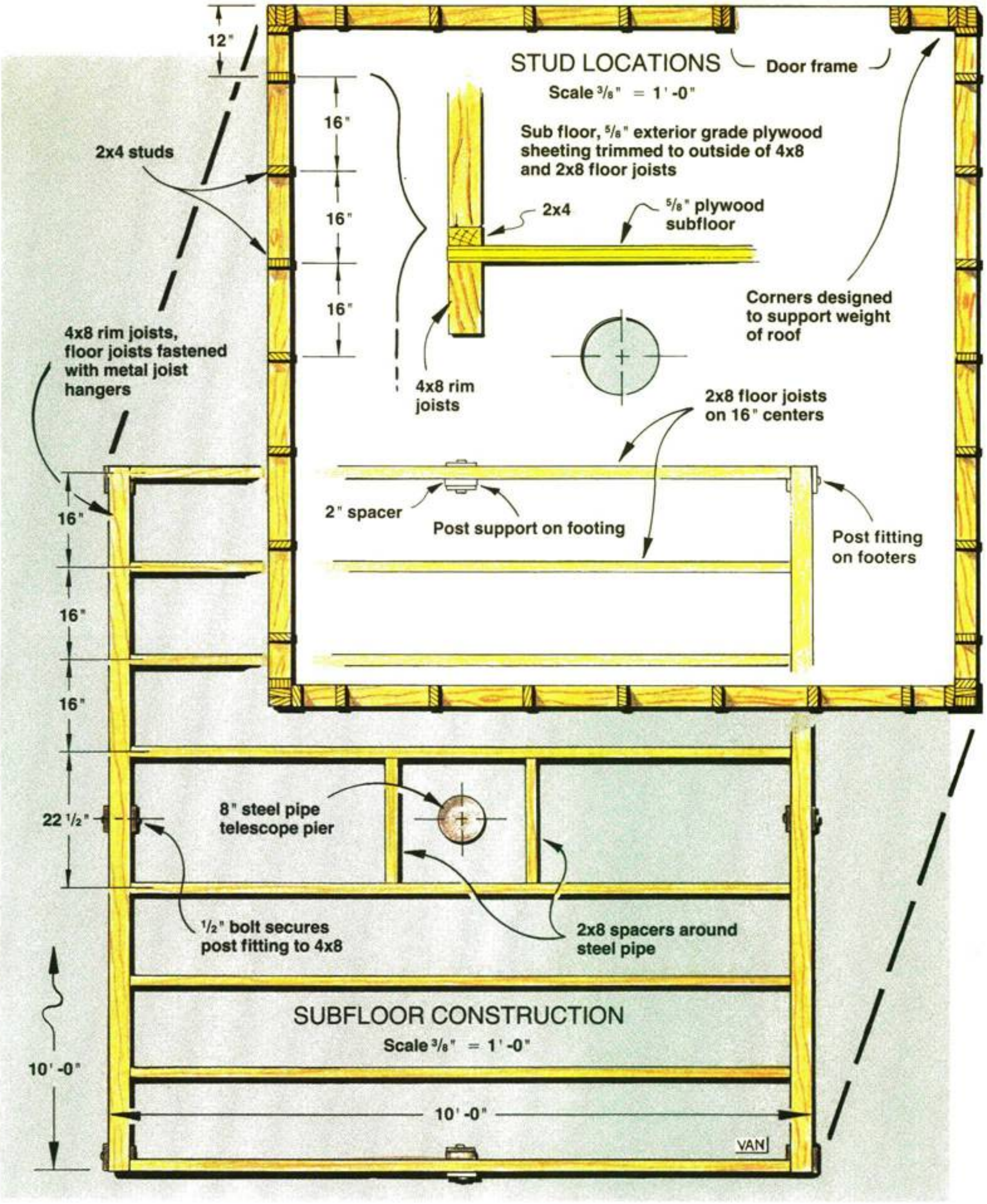
My floor is built over a series of joists that are suspended above the ground by the post brackets set in the footings. The two main rim joists run north-south (see illustration at right). These 4x8 timbers rest directly in the post brackets with 1/2" bolts securing them. If you can't get 4x8s, use two 2x8s nailed together and a 1/2" spacer to hold them securely in the post bracket. I used 2x8s for the floor joists, including the east-west perimeter joists. These joists fit into the post brackets with a 2" spacer. I cut my spacers from 4x4 lumber.

Using metal hangers available from hardware stores, I attached the 2x8 floor joists to the north-south rim joists. I started at the ends of the rim joists and placed the remaining joists on 16" centers. (You may wish to cheat a little on the spacing of the third joist to make it easier to install the subflooring. Move it about 1/2" outwards.) The joists closest to the pier will end up on roughly 22 1/2" centers, which is okay if you use at least 5/8" plywood for the subflooring.

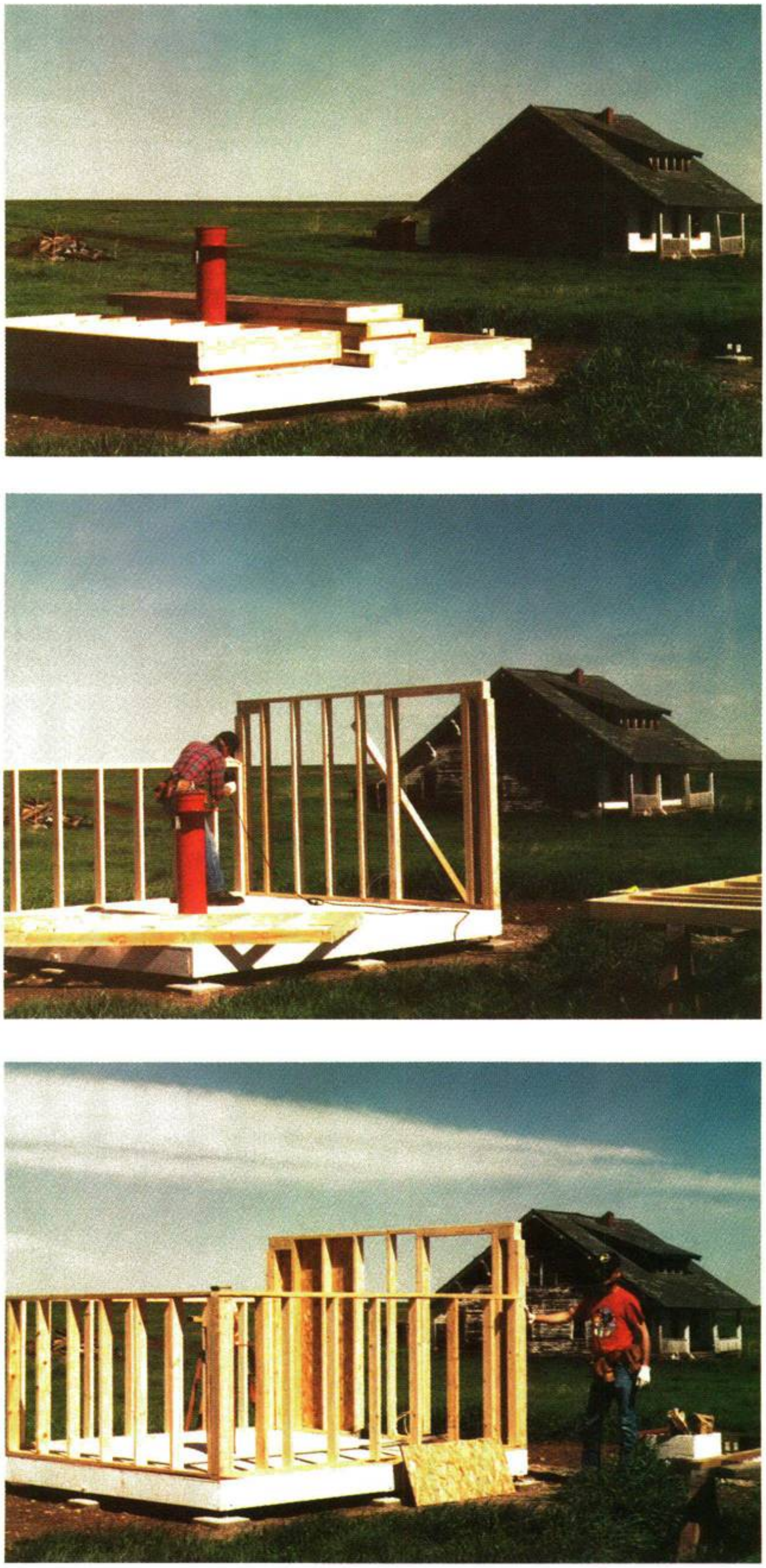
Because the east-west perimeter joists go on the very end of the rim joists, the normal metal hanger doesn't work properly. You can ask your hardware dealer for right-angle brackets that go on just one side of the joist. Alternatively, you could toe-nail the joist to the rim joist.

It is nearly impossible to wire the telescope pier once the subflooring is installed, so take a short break from the floor carpentry and put on your electrician's hat. Run wire through the pier into the conduit that goes between the joists to the future location of the service entrance box. The wires should be enclosed in conduit to prevent animals from gnawing through the insulation. Luckily, working with some of the newer plastics is easier than with the old thick-wall metal variety. Be sure your electrical service is protected by ground-fault circuit interruption (also known as GFCI).

The subflooring is plywood and I attached it directly over the joists. I used 5/8" CDX (inexpensive exterior grade) plywood because I expected to lay particle board as a floor underlayment over this subflooring material. You can use the plywood directly as the floor material, for which you need to use 1" plywood. In this case, you may wish to use a higher grade


12"
STUD LOCATIONS
Scale 3/8" = 1'-0"
Door frame
2x4 studs
16"
16"
16"
Sub floor, 5/8" exterior grade plywood sheeting trimmed to outside of 4x8 and 2x8 floor joists
2x4
5/8" plywood subfloor
Corners designed to support weight of roof
4x8 rim joists, floor joists fastened with metal joist hangers
4x8 rim joists
2x8 floor joists on 16" centers
2" spacer
Post support on footing
Post fitting on footers
16"
16"
16"
22 1/2"
8" steel pipe telescope pier
1/2" bolt secures post fitting to 4x8
2x8 spacers around steel pipe
SUBFLOOR CONSTRUCTION
Scale 3/8" = 1'-0"
10'-0"
10'-0"
VAN

THE FLOOR IS FRAMED with 2x8 joists on 16" centers fastened to 4x8 rim joists on the west and east walls (above). The perimeter joists are bolted to the post supports cast in the concrete footings. Bridging is installed around the pier to help support the 5/8" plywood subfloor.



RAISING THE WALLS is easy once the prefabricated sections are delivered to the site (top). The north wall is erected first and held in place with a temporary support. The west and east walls are fastened to the north wall (middle). Finally, the south wall is screwed in place (bottom).

of plywood (AC) for a smoother floor finish.

Laying a plywood floor is easy. Just be sure that the edge of the plywood lies over a joist. Sixteen-inch centers for the joists make this easy. You can find 4' x 10' sheets of plywood, but more commonly you will find 4' x 8' sheets. Because the floor is 10' x 10', you will need to cut several 2' sections to piece in the rest of the floor. In this case, stagger your joints to make the floor stronger, and place factory edge to factory edge to make a tighter joint. Nail (8d) or screw (2" long) the plywood to the joists about every 6".

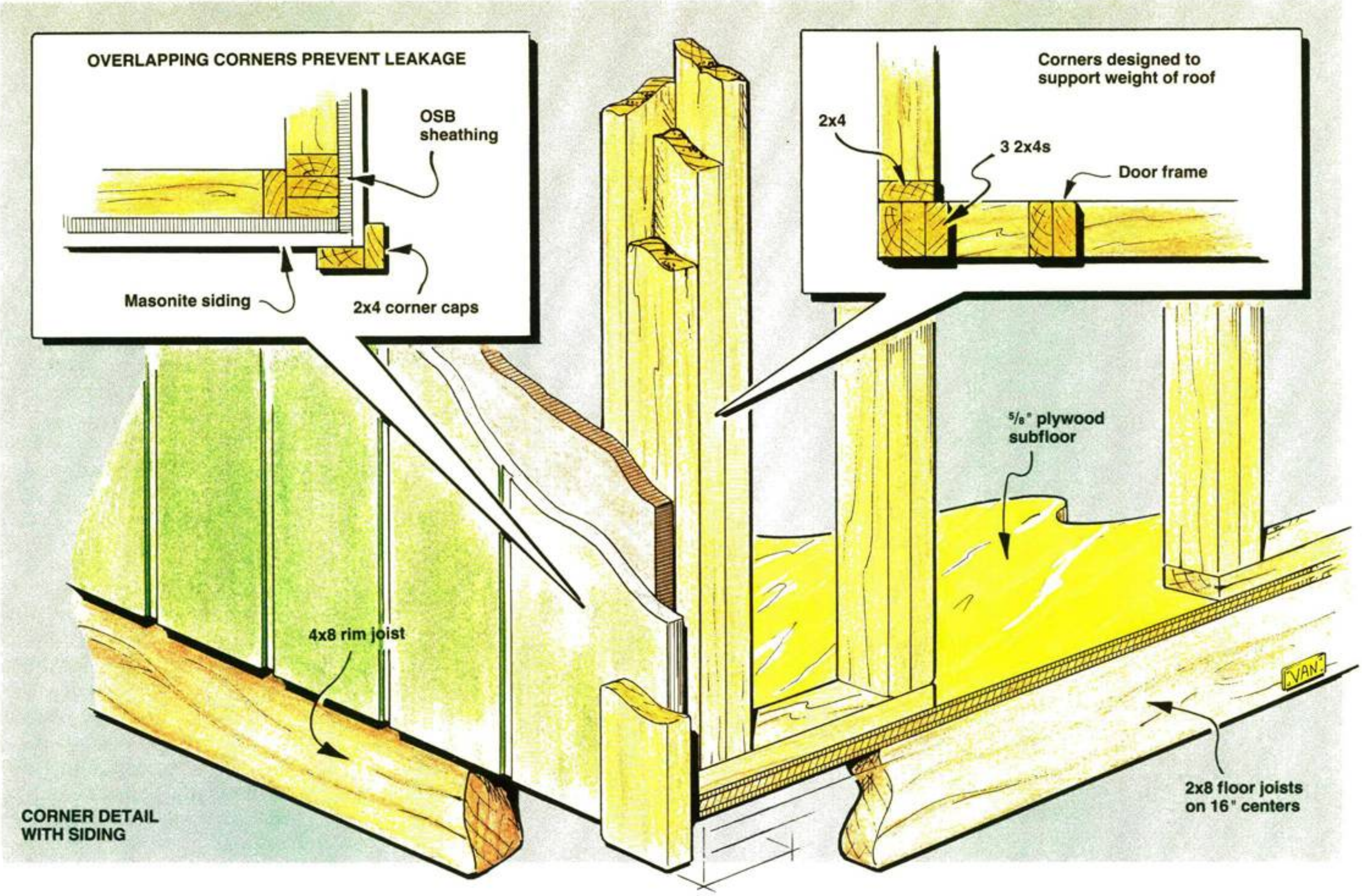
Whatever size plywood you are using, you need to cut a hole in the inner floor section (roughly 22½" wide) for the telescope pier. A hole could be cut in one long section of plywood, but it is easier to piece in two shorter sections of plywood with half-circles cut in one edge. The diameter of the half-circles should be about ½" larger than the pipe so the floor won't rub against the pipe and cause the telescope to vibrate. Bridging — pieces that run at right angles to the joists — cut from 2x8s nailed to the joists near the pier will help to fasten the edge of the plywood. Keep these bridging pieces at least ½" from the pier.

During the construction of the walls and roof, the floor is exposed to the elements. So I gave the floor and exposed portions of the perimeter joists a coat of exterior primer. Then I filled the pier with sand to help dampen the vibrations when I move or bump the telescope. A scrap piece of ¼"-thick steel plate seals the top of the pier. Three holes drilled and tapped in the plate help secure the telescope mount. I formed a collar around this plate from 2"-wide strap iron. Set screws in the collar fasten this assembly to the pier. With this plate in place, we are ready to build the walls.

Building the Walls

During the winter, I prefabricated the walls in my garage and transported them later to the work site in my truck. The garage was warm and I could build the walls squarely, something that would have been harder to do at the work site. Only the fold-down sections of the wall were sheathed in the garage because they are short and light.

I built the walls from 2x4s with bottom and top plates and with studs on 16" centers. Three-inch screws or 16d nails fasten the studs to the plates, two fasteners for each


OVERLAPPING CORNERS PREVENT LEAKAGE
OSB sheathing
Masonite siding
2x4 corner caps
Corners designed to support weight of roof
2x4
3 2x4s
Door frame
5/8" plywood subfloor
4x8 rim joist
2x8 floor joists on 16" centers
CORNER DETAIL WITH SIDING
VAN

SHEATHING THE WALLS with overlapping corners keeps water from penetrating the joints (top). If you can't get large sections of OSB for the sheathing, remember to stagger the joints for strength and place factory edge to factory edge for tight joints (above).

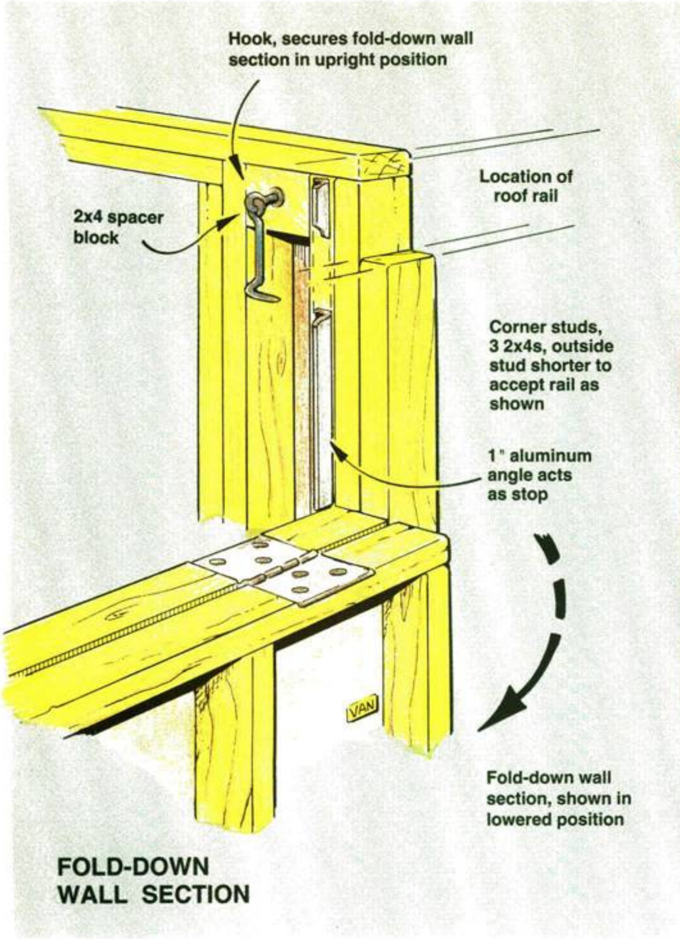
end. I used screws because they won't loosen easily from wind loading on the building.

My floor is exactly 10' x 10', so I cut four sections 9'-8 1/2" long for the west and east top and bottom plates, one section 9'-9" for the north top plate and two sections 9'-5" for the south top and bottom plates. The north bottom plate was cut as two pieces to accommodate the door. I chose a 36"-wide prehung door. The wide door makes carrying equipment in and out easy, and since it was prehung, it was easy to install.

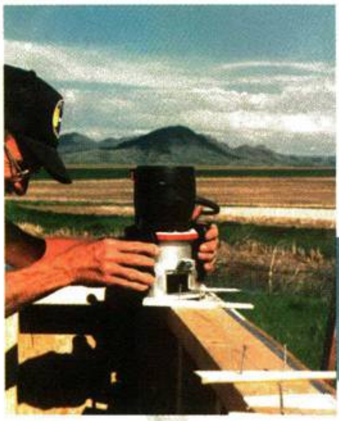
The corner studs in both corners of the north wall and the south corners of the west and east wall (see the illustration on page 83) use three 2x4s nailed together. The two extra backing, or jack, studs provide a solid nailing base for the end studs of the connecting walls and help to support the weight of the roof. The north corners of the west and east walls and both corners of the south walls have single studs. Note that one 2x4 in each corner in the north wall is 4" shorter than the others to act as a support for the roll-off roof rails (see the illustration on page 86).

The frame for the door consists of two studs on each side and a 2x4 header above the door screwed directly to the top plate. The header rests on top of the inner stud of the door frame for extra strength. Since this isn't a load-bearing wall, this simple header is sufficient.

The walls are 6' high. (Check your local building codes to be sure you can use such a low wall for an outbuilding.) The north wall studs were roughly 69" long. A standard 80" exterior door — and its jamb — must be cut down 13" to fit this height and still permit a 1" threshold to seal out the weather. Choose a solid-core door so it may be cut easily to length. The bottom door hinge will have to be repositioned since it was in the part of the door that was cut off. Or have a


Hook, secures fold-down wall section in upright position
Location of roof rail
2x4 spacer block
Corner studs, 3 2x4s, outside stud shorter to accept rail as shown
1" aluminum angle acts as stop
Fold-down wall section, shown in lowered position
VAN
FOLD-DOWN WALL SECTION

FOLD-DOWN WALL SECTIONS swing on four strap hinges routed into the walls (above left and right). Aluminum angles fastened to the jack studs prevent the sections from extending too far when in the raised position. Gate hooks and screw eyes secure the sections when raised. Wood strips guide the router to recess the strap hinges in the wall plates (left). Bolts secure the rails for the roll-off roof to 4x4 posts (below).



millwork company custom build a door and frame for you.

The west, east, and south walls have two sections: the top fold-down section and the rigid bottom section. The fold-down sections use 21" studs, while the bottom sections of the walls use 45" studs.

The studs in the west, east, and south walls are placed on 16" centers from the middle of the wall. Since the 10' wall lengths aren't even multiples of 16", the last studs on each side will lie closer to the corner than 16". This is helpful since reinforced corners will better support the roof load. Three studs in the north wall are placed 16" on center between the corner studs and the double studs for the door frame. (Four studs are shown in the illustration on page 83 because the door opening is shown as 2'.) Small header plates made from 2x4s are screwed or nailed into the corner stud pocket near the top plate (see the illustration on page 86). A gate hook attached to this header secures the fold-down wall section when it is raised.

The fold-down wall sections have top and bottom plates of the same lengths as the rigid wall sections. Unlike the rigid sections, the fold-down sections were sheathed before being moved to the observatory site. I used 3/8" exterior grade oriented-strand board (OSB) for the sheathing.

Look for 4' x 10' sections of OSB or plywood at your lumber store. These large sheets make covering the fold-down sections easy. However, many home improvement stores carry only 8' sections, in which case you will have to piece the sheathing together. Be sure each joint falls over a stud and place the factory edges together for a tight joint. Screw (1 1/2") or nail (6d) the plywood to the plates and studs about every 6".

Erecting the Walls

When the snow cleared from the observatory site and the weather warmed up, I moved the prefabricated walls to the observatory site. The north wall went up first. I aligned the edge of its bottom plate with the outside edge of the floor and screwed the bottom plate through the floor and into the perimeter joists with 3" screws, one screw per stud pocket. I screwed a scrap length of 2x4 loosely to one of the studs. Once the wall was plumb, I screwed the 2x4 to a stake driven into the ground to hold the wall in position during the installation of the other walls. Next, I temporarily placed the other three walls to ensure that everything fit well.

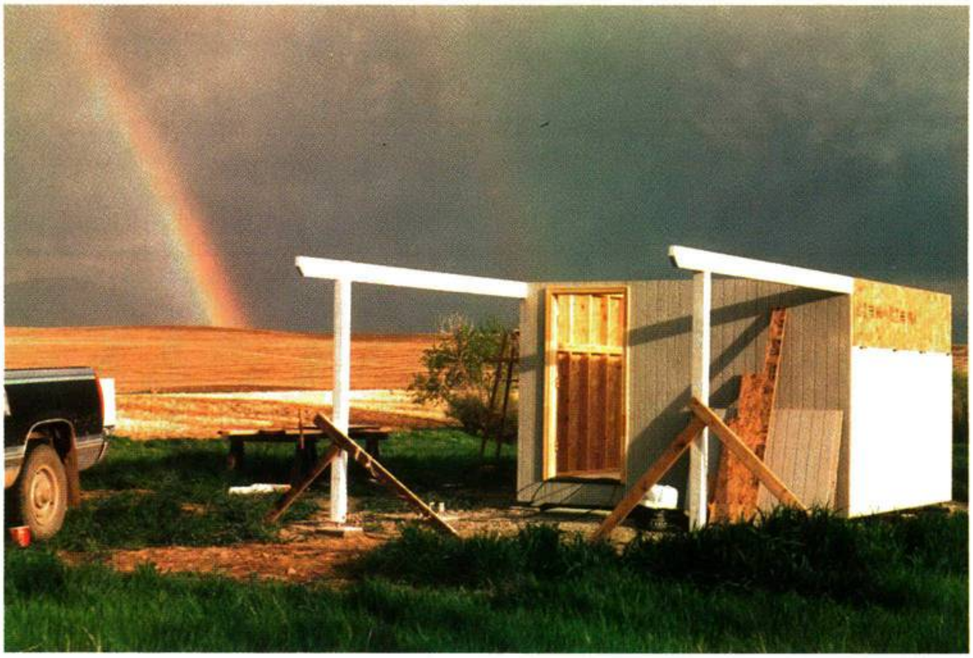
The west and east walls went in next, and screws fastened these walls to the rim joists. Screws driven every 12" also joined these walls to the north wall corner studs. Then I secured the south wall section with screws through the bottom plate into the perimeter joist and through the south wall's end studs into the west and east wall corner studs. The walls were now sturdy enough that the temporary bracing holding the north wall plumb could be removed.

Next I sheathed the rigid wall sections. As with the fold-down sections, I used 3/8" OSB. The sheathing should extend to the bottom edge of the joists. Remember, if you piece the sheathing together, place the factory edges together and stagger the joints for a stronger wall. Be sure that all vertical joints occur over the studs. Screw (1 1/2") or nail (6d) the sheathing every 6" along the edges of the plywood and every 12" along the other stud locations.

When sheathing the walls, it is important to build the corner so it is weatherproof. The sheathing of one wall should be flush with the corner formed by the studs. The sheathing from the adjacent studs should then overlap the sheathing of the first wall (see the illustration on page 85). Extending the sheathing to the bottom of the joist protects the floor-wall plate connection.

Now you can install the door according to the manufacturer's instructions. Once the door operates smoothly and the frame is securely fastened, remove the door until the roof is in place to allow for easier construction. Be sure to allow for the threshold, but do not install it yet. It's a nuisance while construction is underway.

Before installing the fold-down wall sections, you should install the siding. This ensures that the hinge spacing is correct so the top wall section folds down properly. I used 3/8"-hardboard siding. Use long vertical pieces of siding so there are no horizontal joints to trap water, and stagger the joints so they don't fall over the vertical joints in the OSB. Overlap the edges at the corners as you did with the OSB to make the corner weatherproof.



AT THE END OF PHASE 2, the floor, walls, fold-down wall sections, and roll-off roof rails are in place. A good coat of exterior-grade primer will shield the structure from the elements until we can install the roof in part 3 of this series.

Installing the Fold-down Walls

Once the siding was in place, I located the positions for the four strap hinges in each wall section, two hinges about 6" from ends of the wall and the other two spaced evenly in between. I used a router to recess the hinges into the wall plates — two wood strips tacked temporarily into place formed a guide for the router. Once the hinges were fastened securely to the wall plates, the outline of the hinge was traced onto the bottom plate of the fold-down section. (Place a piece of siding between the wall sections so you'll mark the proper hinge location.) After routing these areas, I screwed the fold-down section to the hinges.

As with the rigid wall sections, I installed the west and east sections first so the south section could be test fitted before marking its hinge positions. Two-foot sections of aluminum angle along the north wall corner studs prevent the east and west fold-down sections from extending into the building when raised. Additional pieces of aluminum angle installed along the jack studs of the east and west fold-down sections prevent the south fold-down section from pushing in too far.

I installed headers made from 2x4s into the top corners of each fold-down wall section. Gate hooks and screw eyes screwed in the headers — and those in the north wall — hold the wall sections together when raised. Purchase stout hooks for this purpose because they will be under some strain when the roof rolls on and off the walls.

Roll-Off Roof Rails

The last step of phase two construction is to install the bottom timber of the roll-off roof rails. The shortest member of the corner studs in the north wall supports one end of these rails and posts support the other end. The posts are made from 4x4s and fit into the post brackets north of the building. If the post brackets were installed level with one another, then the height of the posts should be equal to the thickness of the joists, thickness of the floor, and height of the walls. My posts are 6'- 7 7/8" high and have a 1 1/2" deep, 5 1/2" long rabbet cut on the outside portion at top to hold the rail. A 1/2" bolt holds the post to the support. Temporary bracing made from 2x4s kept the posts plumb until the top rails and cross-braces could be installed in phase three of construction.

The rails are made from 13' lengths of 2x6 lumber. The long length permits the roof to be pushed well off the building to give greater access to the northern sky. I screwed one end of the rail to the north wall jack posts and bolted the other end to the post with 4" carriage bolts. To minimize accidents, I beveled the bottom corner of the rail.

The rails signal the end of phase two construction. In the final installment of this series, I'll describe the rest of the roll-off roof rail structure, roof construction, and finishing touches. ☐

Part one of this series appeared in the April issue of ASTRONOMY and the third and final installment will appear in the June issue.

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JUPITER'S ONGOING ACTIVITY

"Jupiter has displayed some splendid phenomena," says Myron E. Wasiuta, an experienced planetary observer living in Woodbridge, Virginia. Wasiuta frequently contributes observations to the Association of Lunar and Planetary Observers and wants to inform ASTRONOMY readers of the current cycle of Jovian activity.

"The planet has displayed increased blue cloud activity throughout the Equatorial Zone," says Wasiuta. "These features arise from the southern edge of the North Equatorial Belt and extend into the Equatorial Zone. The bluish color in these spots is best visible as they transit the planet."

The photograph at right shows two contrasty blue spots apparently "attached" to the North Equatorial Belt. They were first spotted by Wasiuta during early November 1991, and as of January 18, 1992, the spots were still prominent. "They seem to be hanging on," he says. Wasiuta took the photo on November 14, 1991, using the 12-inch f/15 Clark refractor at the U.S. Naval Observatory.

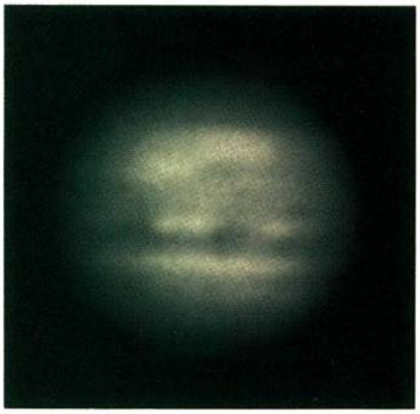
ALPO Jupiter recorders Phillip W. Budine, Isao Miyazaki, and Jose Olivarez reported the following activity as of December 7, 1991: the North Tropical Zone is the brightest such area on the planet; activity in the South Equatorial Belt has subsided and the region has split into two components. The Great Red Spot is faint, particularly its northern half.

Jupiter watchers will be glued to the eyepiece as the show continues this spring.

Winter Meteors. Those who braved the cold last winter saw respectable displays of Geminid and Quadrantid meteors. In December, George W. Gliba of Greenbelt, Maryland, recorded Geminids over several nights. "For some reason I observed more meteors after the supposed shower maximum than during or before it," says Gliba. Along with fellow observer John Sharp, Gliba set out into the midst of the Shenandoah National Park, which features very dark skies. On the 15th, the two observers witnessed 152 meteors between 1:30 and 5:30 a.m. EST, 102 of which were Geminids. "It was bitterly cold," Gliba says, "but the average brightness was magnitude 2.2, and nine of them were brighter than magnitude –1. It was a fine natural fireworks display!"

Geminids were visible in light-polluted skies, too. Observing near Tulsa, Oklahoma, David Stine recorded large numbers of Geminids. On the evening of the 14th, Stine began observing at 1:30 a.m. and saw his first meteor six minutes later. According to his logbook, it was "perfectly clear overhead with no clouds in sight and I could see stars down to about magnitude 4.5 in Tulsa's urban skies."

Over the first 30 minutes of observing, Stine recorded seven meteors, one of them "as bright as Sirius." Then things picked up. Three meteors streaked across the sky in a span of merely 20 seconds, and over one 9-minute stretch Stine observed eight extremely bright meteors. The activity seemed to come in bunches, with long periods of stark, clear skies without meteors in between. By 4:00 a.m. Stine began to witness a sort of grand finale, with 18 meteors putting on a spectacular display over the next half hour. One of them, a greenish meteor "as bright as Jupiter," left a train that persisted for about 3 seconds and stretched over some 20° of sky. "It appeared like the exhaust from a jet airplane," says Stine. "That's the great thing about meteor astronomy: great sights can show up at any moment." Not a bad reason to brave the cold — *David J. Eicher.*



SOLAR SYSTEM EVENTS of recent months include blue cloud activity on Jupiter (right, visible as dark areas associated with the North Equatorial Belt) and the Quadrantid meteor shower (below, two Quadrantids near Jupiter). Photos by Myron E. Wasiuta (right) and Gert Kroner (below).

EXPLORING THE DEEPEST OF SKIES

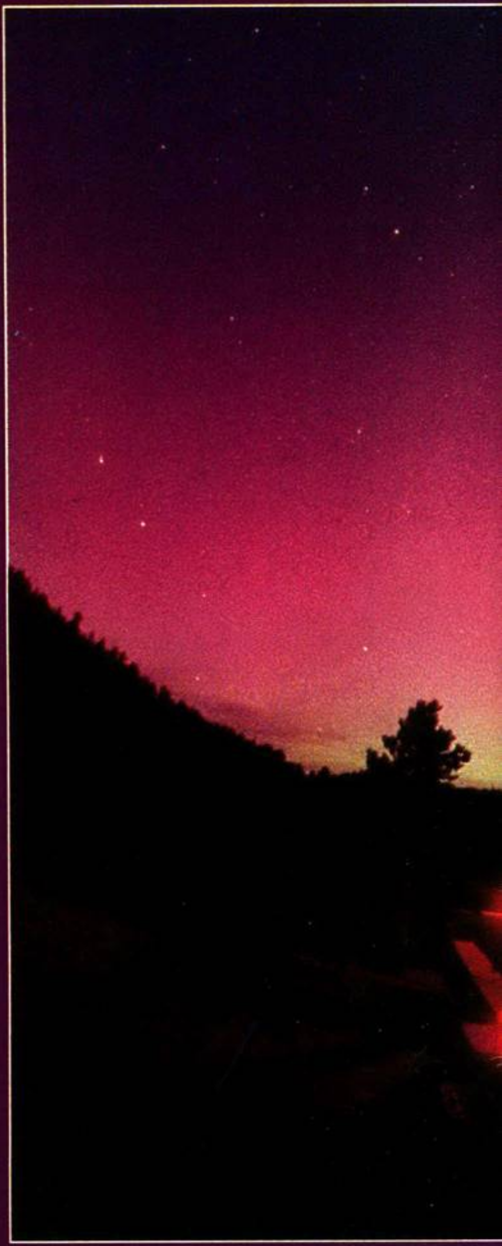
When Gary Becker arrived at New Mexico's Star Hill Inn for a vacation, he expected to take full advantage of the crisp, dark skies. Becker unpacked and enjoyed the darkening night of November 8, 1991, but soon watched the sky over Sapello glow with aurora. Becker's photo of the event (right) wins this month's $100 "Best Astrophoto" award.

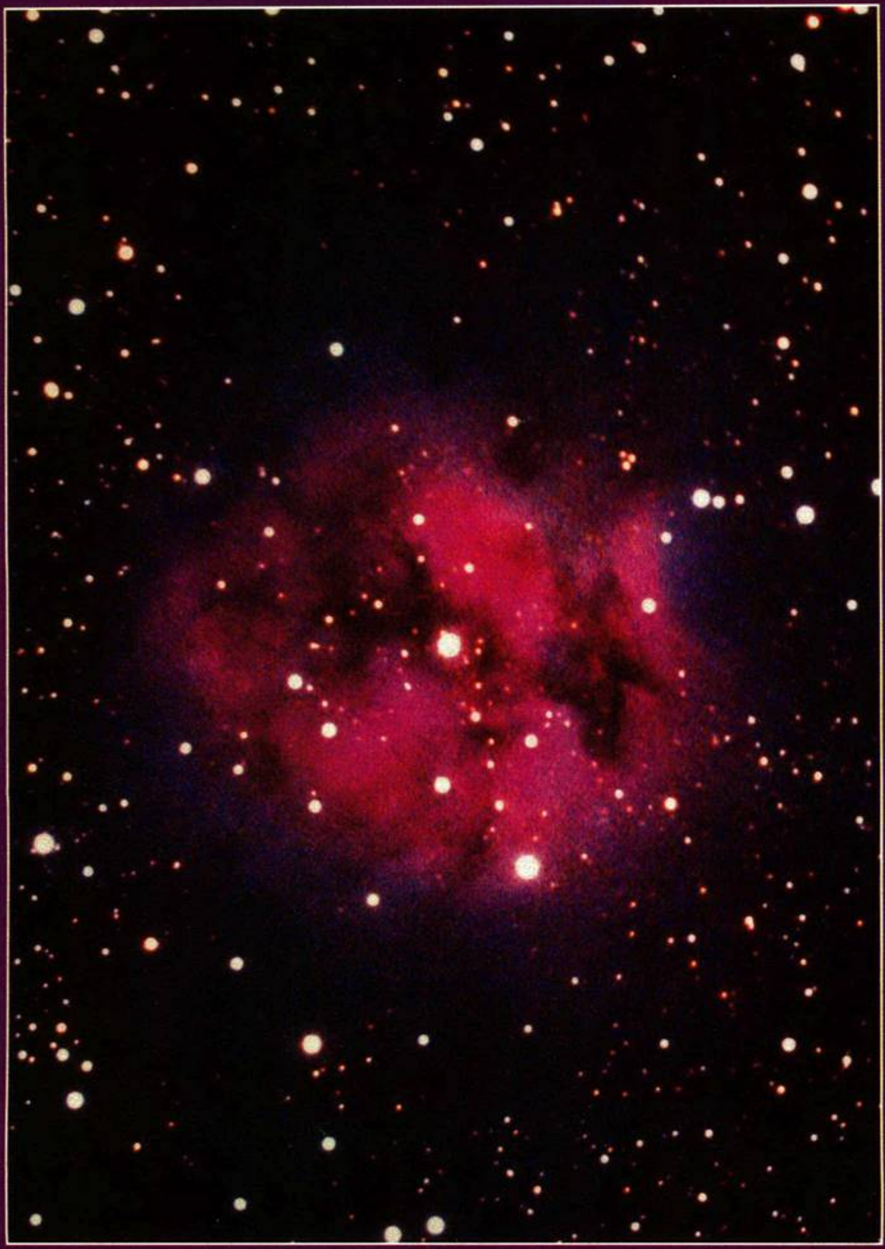
Deep-sky photographers successfully eluded the aurora to record deep images of nebulae and galaxies. Under the dark skies of Nevada, George Greaney and Mike Newton photographed the elusive Cocoon Nebula in Cygnus (below), capturing the nebula's ruddy hydrogen light.

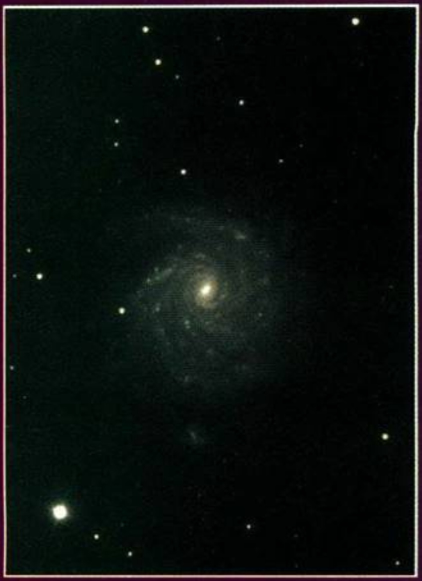
Chuck Vaughn captured another low surface brightness object, the Helical Nebula in Aquarius; his is a deep photo made under a dark, transparent sky (opposite page, bottom right).

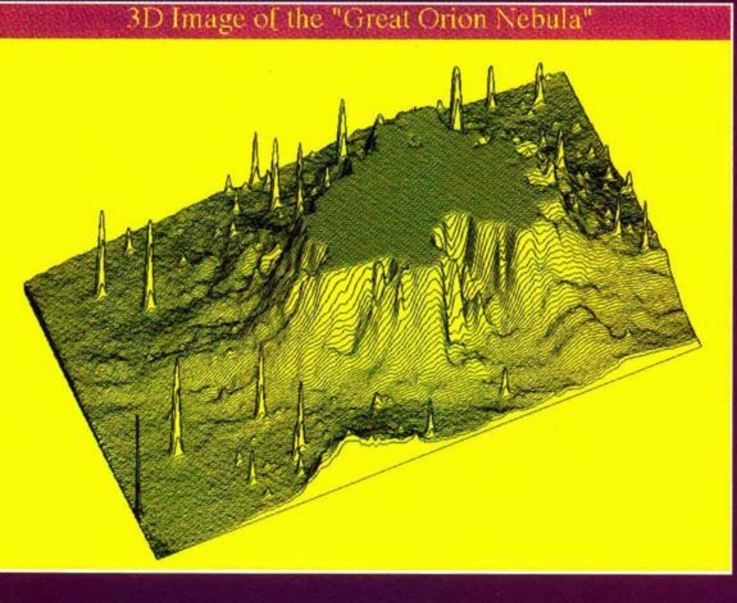
The many-armed spiral NGC 1232 is distinctly brought to life in Kim Zussman's long exposure (bottom right).

CCD experimenter George Fowler imaged the Orion Nebula with a 14-inch SCT at Tidewater Community College in Portsmouth, Virginia. He then used software to turn the image into Andy Warholesque art that depicts a three-dimensional brightness plot of the inner part of the nebula (opposite page, bottom left).





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Orion is America's # 1 Choice for Celestron Telescopes, Binoculars, and Accessories!

If you are thinking about buying a Celestron telescope, Orion is the place to buy it. We've sold thousands of Celestron telescopes to amateur astronomers across the USA. Our low, low prices and special accessory packages can really save you a bundle! Whether you are considering a big telescope or a small one, or a binocular or accessory, chances are Orion has just what you are looking for. And we probably have it in stock for immediate delivery, too!

Celestron telescopes are available with a variety of mounts, including German-style equatorial or fork mounts, with a wide range of available drive systems including the renowned CompuStar computer-controlled mount. A huge selection of models up to 14" in aperture, in all price ranges, available for immediate delivery!

Schmidt-Cassegrains — Celestron pioneered these fantastic instruments, and has an enviable reputation for building unsurpassed, exquisitely fine Schmidt Cassegrain optical systems.

Refractors — Celestron's wide range of refractor models covers the full range of apertures where the refractor is well suited to portable use, up to 102mm diameter. Models include the incredible 102mm Fluorite apochromat, ideal for the advanced refractor enthusiast.

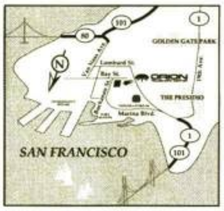
Reflectors — Celestron's popular reflector telescopes feature superb optical performance and full-featured, precision equatorial mounts which permit a full complement of optional accessories including electronic drive systems.

Thinking about your first telescope?

Call our telescope experts Toll Free with any questions you may have. Please don't be embarassed if you don't understand everything or are a bit overwhelmed. We've been helping first-time buyers for 17 years, and we're happy to help smooth your path to this fascinating hobby!

When You're in the San Francisco Bay Area, Visit One of Our Three Unique Retail Stores.

America's biggest & best selection of telescopes, binoculars & accessories. Now 3 convenient Northern California locations!



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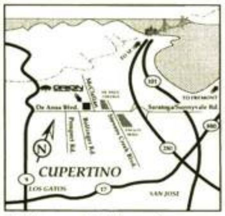

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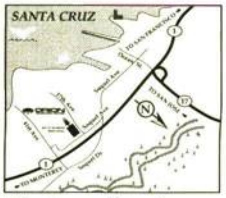

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❶ SpaceProbe 4.5 Reflector

Great 4.5" f/8 reflector, ideal for planetary and deep space. Equatorial mount, slow motion controls, setting circles. 6x30 finder plus 25mm (36x) and 9mm (100x) 1.25" eyepieces. Deluxe tripod.

#9099 **$399** (22.19)

❷ Sky Explorer 80 Refractor

Perfect for planetary and lunar observation. Equatorial mount, loaded with accessories: two eyepieces, 2x barlow, erecting prism, 6x30 finder, sun screen, moon filter, star diagonal, tripod and accessory tray.

#9098 **$539** (32.66)

❸ Sky Explorer 60 Refractor

Ideal for lunar and planetary study, plus it's a powerful terrestrial telescope. 900mm f.l, 6x30 finder; star diagonal ; two eyepieces, equatorial mount; setting circles; tripod; and lighted accessory tray.

#9092 **$349** (13.22)

❹ TeleVista 60mm Refractor

Equally at home viewing the rings of Saturn or boats across the bay. Two quality eyepieces, all metal optical tube and yoke mount, finder scope, adjustable tripod, diagonal prism.

#9091 **$199** (8.97)

OmniVista 60 Multipurpose Refractor

High performance 420mm f/7 60mm rich field scope. Makes a great compact astrograph, telephoto lens, spotting scope, or guide scope.

#9090 **$249** (5.94)

OmniVista 80

Hot ED apochromat, 80mm f/6.25 fantastic optics with great 2" focuser, 6x30 finder. Eyepiece/diagonal extra.

#9080 **$444** (6.89)

TeleVue

Orion is your # 1 Source for TeleVue! See our catalog for Tele Vue scopes and accessories.

- **Plössl Eyepieces**
- **Nagler Eyepieces**
- **Panoptic Eyepieces**
- **Wide Field Eyepieces**
- **Systems Mount**
- **Panoramic Mount**

Genesis Refractor

Free 16mm Nagler Eyepiece $299 Value! With purchase of Genesis at Orion!
Limited offer

Incredible Selection of Astronomy Binoculars

50mm Observer™ Binoculars

Fine quality, moderately priced binoculars, excellent for both astronomy and daytime observation. Fully coated optics, rugged ribbed rubber covering for a good grip. Both have a 7° field of view.

New Low Price!

7x50 #9620, 10x50 #9623 **$79.95** (4.44)

50mm Explorer™ Binoculars

Our newest high performance binoculars with BAK-4 prisms and Multi-Coatings. Great for both astronomy and daytime observation. Comfortable ergonomic body design.

New Low Price!

7x50 #9306, 10x50 #9308 **$99.95** (4.71)

50mm Adlerblick Binoculars

Incredible wide field eyepiece design, Fully Multi-Coated, BAK-4 prisms, and best special glass objective lenses make the 7x50 Adlerblick the arch rival of European brand binoculars selling for 3-4 times the price. Orion buys direct, saving you money. Includes deluxe hard case, lens caps and straps.

7x50 #9612 **$279** (5.28)
10x50 #9610 **$269** (5.28)

Orion® 8x56 Mini Giants

56mm objective lenses gather over 2.5x the light of ordinary 7x35 binoculars. Perfect for viewing faint celestial objects, daytime viewing. Best Multi-Coated BAK-4 optics. 6° field of view. Standard model 33 oz. Rubber Armored for protection from bumps. Weighs 37 oz.

Rubber Armored Model #9627 **$149** (5.07)
Standard Model #9504 **$149** (4.71)

Orion® 10x70 FMC Giants

The standard for hand-holdable astronomy binoculars. Fully Multi-Coated. 33% lighter—weighs only 58 oz.—yet the same brightness and 7mm exit pupil as our 11x80 MC model. Superior 'BCF' body design. Includes: soft rubber eyecaps, tripod mounting adapter, durable hard carrying case, lens caps and straps.

#9501 **$299** (6.97)

80mm FMC Giant Binoculars

20% more light transmission than ordinary "fully coated" binoculars. Fully Multi-Coated optics and superior BAK-4 prisms provide fantastic contrast and greatly improved edge sharpness.

11x80 MC- Brightest, widest field available. Ideal for deep-space observation under dark skies. Hand-holdable.

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16x80 MC- 45% higher power, excellent for astronomy and daytime observation. Tripod recommended.

#9496 **$379** (8.05)

20x80 MC- Highest power model perfect for smaller deep-space objects and long range daytime views. Tripod required.

#9498 **$389** (8.05)

SuperGiant™ 14x100 FMC

Gigantic, almost 4 inch, lenses gather 156% of the light of 80mm binoculars. Individual eyepiece focus, fully multi-coated optics and BAK-4 prisms. Comes with tripod mounting plate and metal-clad case. 14x magnification, field of view 3.3°, exit pupil 7.0mm, weight 7.5 lbs., height 13.5".

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6mm #8536, 9mm #8538, 12mm #8540, 18mm #8508, 25mm #8510, 40mm #8512
$34.95 ea. (2.98)

***Orthoscopic Eyepieces**—Excellent Performance*
5mm #8500, 7mm #8502, 9mm #8504, 12.5mm #8506, 18mm #8524, 25mm #8526
$44.95 ea. (2.98)

77° Field UltraScan™ Eyepieces

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1.25" UltraScan Eyepieces
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15mm #8422 **$129** (3.67)
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30mm 2" UltraScan Eyepiece #8424 **$219** (4.71)

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Unlike other premium eyepieces, Orion Ultrascopics offer complete multi-layer coatings on ALL surfaces, for superior light transmission and contrast. Modern 5- and 7- element designs for pinpoint star images and breathtaking detail. Wide 52° field of view. Guaranteed to beat other brands selling for much more! Unsurpassed high-performance design!

Medium-High Power 5-element
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$64.95 ea. (3.45)

Wide Field 5-element
25mm #8564 **$79.95** (3.45)
30mm #8562 **$84.95** (3.45)
35mm #8560 **$89.95** (3.45)

***High Power 7-element** —Long Eye Relief*
5mm #8574, 3.8mm #8576
$89.95 ea. (3.45)

Explorer .965" Eyepieces

Get the most from your telescope with these fine Multi-Coated eyepieces. Standard .965" barrels fit most smaller telescopes.

.965" Orthoscopic Eyepieces 5mm #8580, 7mm #8581, 9mm #8582, 12.5mm #8583
$42.95 ea. (2.98)

.965" Kellner 18mm #8584, 25mm #8585
.965" Achromatic Huygenian 40mm #8586
$33.95 ea. (2.98)

UltraZoom™ 7–21mm

The finest zoom you can buy for your 1.25" telescope. An excellent choice for astronomy or terrestrial observing. 65°-35° field. Fully coated.
#8556 **$139** (3.67)

12mm Kellner Illuminated Reticle Eyepiece

12mm Kellner eyepiece with cable plugs into power panel drive bases, and most drive correctors with illuminated reticle output for polar alignment and guiding.
#8482 **$69.95** (3.45)

9mm Illuminated Reticle

9mm Orthoscopic eyepiece with wireless adjustable brightness illuminator. Bull's-eye within three concentric circles helps measure limits of acceptable guiding error.
#8488 **$119** (3.67)

Orion® 12.5mm Plössl Illuminated Reticle Eyepiece

This new 12.5mm 4-element Plössl offers unprecedented eye relief and observing comfort during long astrophoto exposures. The battery operated integral illuminator has fully adjustable brightness. Features double crossline reticle.
#8484 **$99.95** (3.45)

6mm Illuminated Reticle

6mm Orthoscopic design for high power guiding, unique X-Y adjustable reticle positioning for easy guide star alignment. Wireless LED illuminator has adjustable brightness.
#8487 **$149** (3.67)

Orion Plössl Eyepieces

Orion Multi-Coated Plössl eyepieces are fine performers at an amazingly low price. Precision 4-element Plössl lens elements mounted in sturdy aluminum barrels. Available in 12mm, 18mm, or 25mm focal lengths, with 1.25" barrels. Buy all three for less than some single eyepieces!
12mm-#8596; ***18mm***-#8597; ***25mm***-#8598
$42.95 ea. (2.98)

MegaVista™ Wide Angle

Incredible Fully Multi-Coated high-transmission 7-element eyepieces with integral rubber eyeguard and long eye relief.

10.5mm An incredible 67° field for outstanding planetary or deep space performance.
#8552 **$119** (3.67)

16.8mm Outstanding high-contrast eyepiece with stunning 70° field ideal for deep space.
#8554 **$119** (3.67)

VariPower™ 2-3x Barlow

Our best barlow fills the gaps in your eyepiece collection. Internal lens cell slides easily to adjust magnification. Quality optics provide excellent sharpness, contrast and brightness. Works with 1.25" diameter eyepieces and right-angle diagonals.
#8748 **$59.95** (3.45)

Ultrascopic 3-Element Barlow

Fully Multi-Coated 3-Element Barlow lens provides superior imaging with precise color correction at three wavelengths. For maximum light transmission and highest contrast, we have used the finest quality multi-coating on each air to glass surface. 1.25" diameter.
#8750 **$54.95** (3.45)

Fully-Baffled Barlow Lens

Fully internally opaqued and baffled to block stray light for noticeably higher contrast. Large 27mm multi-coated 2-element lens provides 2x magnification with any 1.25" eyepiece.
#8746 **$44.95** (2.98)

Filters

Color Eyepiece Filters

Highest quality precision-ground optical glass. Fully anti-reflective-coated. Piggyback precision aluminum cells. Solar system observations are dramatically improved by Orion colored filters. Thread one into the barrel of any standard eyepiece. Can also be threaded directly into a universal camera adapter.

.965" Basic Set of 4 Filters Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.
#5510 **$34.95 set** (2.98)

1.25" Basic Set of 4 Filters #5514
Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.
1.25" Expansion Set of 4 Filters #5516
Includes #21 Orange, #47 Violet, #11 Yellow-Green, #82A Very Pale Blue.
1.25" Advanced Set of 4 Filters #5570
Includes #8 Light Yellow, #23A Light Red, #38A Deep Blue, #56 Light Green.
$39.95 set (2.98)

More Color Eyepiece Filters

Deluxe Set of 8 Filters for 1.25" Includes all the filters in our basic and expansion filter sets.
#5517 **$74.95** (3.45)

Full Set of 12 Filters for 1.25" Includes Basic Set, Expansion Set, Advanced Set.
#5575 **$109** (3.67)

Individual 1.25" Filters- #80A Blue (#11040), #58 Green (#5540), #25 Red (#5536), #15 Yellow (#5532), #21 Orange (#5534), #47 Violet (#5538), #11 Light Yellow-Green (#5530), #82A Very Pale Blue (#5544), #8 Yellow (#5571), #23A Light Red (#5272), #38A Deep Blue (#5273), #56 Light Green (#5274)
$11.95 ea. (2.43)

Moon Filters

Cuts 87% of the light from the Moon. Reduces glare by uniformly reducing light transmitted over the entire spectrum.
.965" #5664 **$13.50** (2.43)
1.25" #5662 **$13.50** (2.43)

SkyGlow™ Light Pollution Filters

Enhance your viewing of faint deep sky objects with the best broadband light pollution filter you can buy. Our SkyGlow absorbs frequencies emitted by city lights, allowing transmission of the rest of the visible spectrum, yielding dramatic results.

SkyGlow Broadband Filters—Photographic and Visual
For use in slight to moderately light polluted areas.

1.25" Broadband Filter–fits 1.25" eyepieces.
#5660 **$59.95** (3.45)

Schmidt-Cassegrain Broadband Filter–fits rear cell of Meade & Celestron SC scopes.
#5658 **$79.95** (3.45)

52mm Broadband Filter–For 52mm camera lenses, adapter rings available for other diameters.
#5668 **$79.95** (3.45)

SkyGlow UltraBlock Filters–Visual Only
For severely light polluted areas and faint nebulae.

1.25" UltraBlock Filter–fits 1.25" eyepieces.
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Schmidt-Cassegrain UltraBlock Filter–fits rear cell of Meade & Celestron SC scopes.
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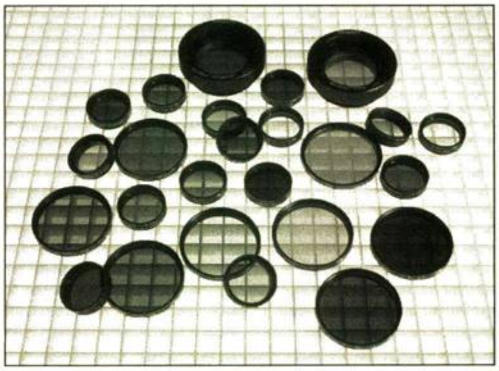

Accessories

Star Diagonal Prisms

1.25" Star Diagonal Primarily for astronomical use, lets you view at a right angle. Multi-Coated, for 1.25" eyepieces.
#8763 **$39.95** (2.98)

.965" Star Diagonal Same as 1.25" Star Diagonal, but with standard coated optics. Works with .965" eyepieces and eyepiece holders.
#8761 **$24.95** (2.98)

45° Erect Image Diagonals

.965 Diagonal #8759 **$69.95** (3.45)
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2" Mirror Star Diagonal

Get the widest possible field of view from your Schmidt-Cassegrain Telescope. This star diagonal features a special aluminized and overcoated precision first-surface flat mirror.
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BigEye™ 50 & 80mm Finder Scopes

You might spend more time viewing through the finder than through your main telescope! Four models ideal for upgrading any telescope including Schmidt-Cassegrains. Available non-illuminated or with wireless, adjustable, battery-operated illuminated reticle.
Call toll-free for info/prices

Rack & Pinion Focusers

These top quality focusers are designed for Newtonian reflectors. Fit any size tubes.
1.25" Focuser #13017 **$42.95** (2.98)
2" & 1.25" Focuser #13019 **$79.95** (3.95)

Orion® UltraGuider™

Advanced features at a low price. Use with Meade or Celestron SC. Easily adjustable prism. Ultra-precise helical focus of your eyepiece, adjustable camera focal plane position.
#5139 **$119** (4.19)

Orion® Premium Off-Axis Guider

High performance, Multi-Coated, precision anodized. Low Orion price!
#5144 **$49.95** (3.45)

Basic Camera Adapters

Combination Eyepiece Projection Tube and Prime Focus Adapter for refractors and reflectors with 1.25" eyepiece holders. Use with T-Ring (sold separately).
.965" #5268 **$24.95** (2.98)
1.25" #5264 **$29.95** (2.98)

Vari-Power Camera Adapter

Unique sliding barrel design allows variable projection distances during eyepiece projection photography, eliminating the need to change eyepieces when magnification changes.
#5262 **$39.95** (2.98)

Orion® T-Adapter for SC

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Orion® Dew Zapper

Orion's Dew Zapper is a sure-fire cure for dew problems on your 8" or 10" Celestron or Meade Schmidt-Cassegrain telescope. Dew Zapper gently replaces lost heat, bringing the corrector plate temperature slightly above air temperature.

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AC Model #3504
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10" Dew Zappers fit all Meade 10" Schmidt-Cassegrains
DC Model #3506,
AC Model #3508
$49.95 (2.98)

Dew Remover Gun

Moisture that interferes with viewing dissipates quickly with this 12V DC, 15 watt warm air gun. Has 4-1/2' cord.
#5601 **$17.95** (2.78)

Starlite Red LED Flashlight

The Starlite is the only adjustable-brightness night-vision red flashlight. Lifetime solid-state LED can't burn out. Extra efficient electronic circuit for long battery life. Uses one 9-volt battery (not included).
#5714 **$24.95** (2.43)

Astronomer's Flashlight

Indispensable and indestructible. Has special night-vision red filter and a diffusion lens for even illumination. An essential addition to your astronomy accessories. Requires 2 D-cell batteries (not included).
#5701 **$9.95** (1.79)

Deluxe Accessory Cases

Keep accessories and camera safe and clean. Diced foam inserts can be tailored to your needs. Sturdy handle, two latches, key.
Regular Case: 16"x12"x6 1/2"
#5920 **$59.95** (6.67)
Large Case: 19 1/2"x12"x6 1/2"
#5921 **$69.95** (7.10)

Deluxe Eyepiece Case

Organize and protect your valuable eyepieces and other accessories. This durable case with double hinges holds up to 10 eyepieces plus barlow. Die cut foam insert for snug secure fit. O.D. 8-1/2"x12-1/2"x3-1/8".
#5913 **$17.95** (2.78)

Field Tripod Tote Bag

Designed for the field tripod with padded insert to separate wedge from tripod during transportation. Specifically made for wedge combinations of Schmidt-Cassegrain telescopes up to 10" aperture. Allows storage without changing polar alignment. This blue bag is made of tear, rip and mildew resistant 100% Cordura nylon.
#15096 **$79.95** (5.19)

Observer's Chairs

Make observing more comfortable and enjoyable with one of these great chairs.

Standard Model—Has adjustable height center column and padded vinyl seat. Folds for easy storage.
#5935 **$39.95** (4.79)

Deluxe Model—is much heavier-duty, built for professional musicians. Extra thick padding, wide footprint. Adjustable and disassembles for storage.
#5934 **$89.95** (8.02)

12 Amp Hour Porta Pac Battery

Ideal for operating your telescope plus higher power-consuming accessories such as an Orion Dew Zapper. Battery is encased in high impact polystyrene. Carrying case of Cordura nylon with shoulder strap and handle. Wt. 10 lbs.
#2354 **$109 ea.** (8.97)

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A LUNAR ATLAS TO TREASURE

Atlas of the Moon, by Antonín Rükl, (Hamlyn, 1990), ISBN 0-600-57190-4, 224 pages, sewn binding, hardcover, £19.99.

Every lunar observer should have this book. It costs roughly the same as an ordinary eyepiece, it's just about as useful, and given care it will probably last nearly as long. Even armchair lunar explorers will find it an appealing item to browse through.

Atlas of the Moon contains 76 maps of the Moon's Earthside hemisphere, beautifully and carefully rendered in ink and wash. In 1976 Rükl published these maps in a pocket-sized book titled *Moon, Mars & Venus*. In that work the maps measured about 3¼" by 4½"; in the new version, they are a little larger than 5" by 7". (The new atlas pages measure 8½" by 11½".) In the old version, the lunar surface was rendered in a reddish tint; in the new it's a pleasing greenish gray, about the same color as cement powder. The names of objects appear in black and the grid pattern of lunar latitude and longitude in red.

Comparing the new map plates under red light with the old version makes the new maps' superiority abundantly clear. The features plotted are much easier to see. Moreover, the larger plate size helps you pick out the small details of central peaks, rilles, and the like, which formerly went astray in the clutter of a crowded region. Each map stands on the right-hand page with the numbers of the adjoining map plates printed in the margin. Facing it is a gazetteer of the major features portrayed, with brief biographical notes on the people commemorated. (Rükl has updated the names of lunar features to conform with the official IAU nomenclature as of 1988.)

The introductory material to the atlas contains explanations of lunar phases and the Moon's surface features, origin, and history. After the atlas plates, eight special charts show maps of the intermittently visible lunar libration regions. Another section has 50 photographs of various features and areas of special interest, such as Ptolemaeus, Tycho, Gassendi, the Alpine Valley, and so on. Other sections briefly cover lunar observation techniques and eclipses. A glossary, bibliography, and full index of named formations round out the work. The front endpapers have an index map showing the location of each of the atlas's 76 maps, while the back endpapers show the locations of the 50 photos reproduced in the text.

This wonderful book has one flaw: the charts have north at top. This means that all the labels on a map are upside down when you use it at the telescope. Some observers will be put off by this; others such as myself don't really care. I can learn to read names upside down pretty quickly, and when identifying features on photos the north-up orientation doesn't matter anyway.

Observers using star diagonals (common with refractors and Schmidt-Cass scopes) will encounter another problem. The image in their eyepiece is flopped left-for-right compared to the atlas page. To fix this, at least as far as terrain goes, some observers photocopy the map pages and view the copy from the back on a red-lit light box placed near the telescope.

Despite the flaw, which seems minor to me, I'm delighted to have this new edition available. Not only are these beautiful maps bigger and printed better, but the binding on my old copy of *Moon, Mars & Venus* had just about fallen apart! — *Robert Burnham*

General Astronomy

Time For the Stars, by Alan Lightman, (Viking, 1992), ISBN 0-670-83976-0, 124 pages, hardcover, $20.

At the start of each decade, the National Academy of Sciences undertakes an assessment of the entire field of astronomy. Deriving from the most recent such study, Alan Lightman's book is a guide to the astronomy of the 1990s. Lightman writes easily and gracefully, and this book will give any interested lay reader a clear guide to what astronomers of all kinds will be working on this decade.

Images of the Universe, edited by Carole Stott, (Cambridge University Press, 1992), ISBN 0-521-39178-4, 237 pages, sewn binding, hardcover, $54.95; paperback $24.95.

Sixteen amateur and professional astronomers collaborate here on a book that outlines recent developments in astronomy. Topics covered include the planets, comets and meteors, the Sun, stars and their evolution, variable stars, supernovae, pulsars, the Milky Way

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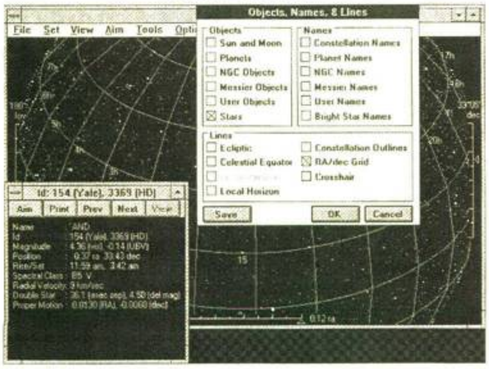

Objects: ☐ Sun and Moon ☐ Planets ☐ NGC Objects ☐ Messier Objects ☐ User Objects ☒ Stars
Names: ☐ Constellation Names ☐ Planet Names ☐ NGC Names ☐ Messier Names ☐ User Names ☐ Bright Star Names
Lines: ☐ Ecliptic ☐ Celestial Equator ☐ Local Horizon ☐ Constellation Outlines ☒ RA/dec Grid ☐ Crosshair

Id: 154 (Yale), 3369 (HD)
Name: AND
Id: 154 (Yale), 3369 (HD)
Magnitude: 4.36 (vis) -0.14 (UBV)
Position: 0.37 ra 33.43 dec
Rise/Set: 11.59 am, 3.42 am
Spectral Class: B5 V
Radial Velocity: 9 km/sec
Double Star: 35.1 (asec sep), 4.50 (del mag)
Proper Motion: 0.0130 (RA), -0.0080 (dec)

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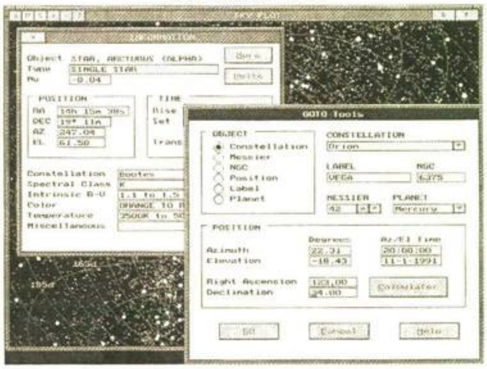

Object: STAR, ARCTURUS (ALPHA)
Type: SINGLE STAR
Mv: -0.04
POSITION: RA 14h 15m 38s, DEC 19° 11m, AZ 247.04, EL 61.50
Constellation: Bootes
Spectral Class: K
Intrinsic B-U: 1.1 to 1.5
Color: ORANGE TO R
Temperature: 3500K to 50

OBJECT: ● Constellation ○ Messier ○ NGC ○ Position ○ Label ○ Planet
CONSTELLATION: Orion
LABEL: VEGA
NGC: 6375
MESSIER: 42
PLANET: Mercury
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Galaxy, quasars, and the origin of the universe. The level of presentation is aimed at lay readers, and there are many color illustrations.

The Universe Unfolds Space Atlas, (VanDam Publishers), ISBN 0-931141-43-5, folded maps in cover, $9.95.

Four unfolding "star dome" maps of the night sky as seen from the Northern Hemisphere form the core of this item. The skies of winter and spring are in the front; summer and autumn in the back. In the center is an 18-page text discussing such topics as meteors, eclipses, deep-sky objects, simple astrophotography, and how to use the charts. Aimed at beginners under typical suburban skies, the star charts go to about 3rd magnitude and show only the brighter constellations and their stars. The charts each measure about 10" by 12" and fold in upon themselves neatly.

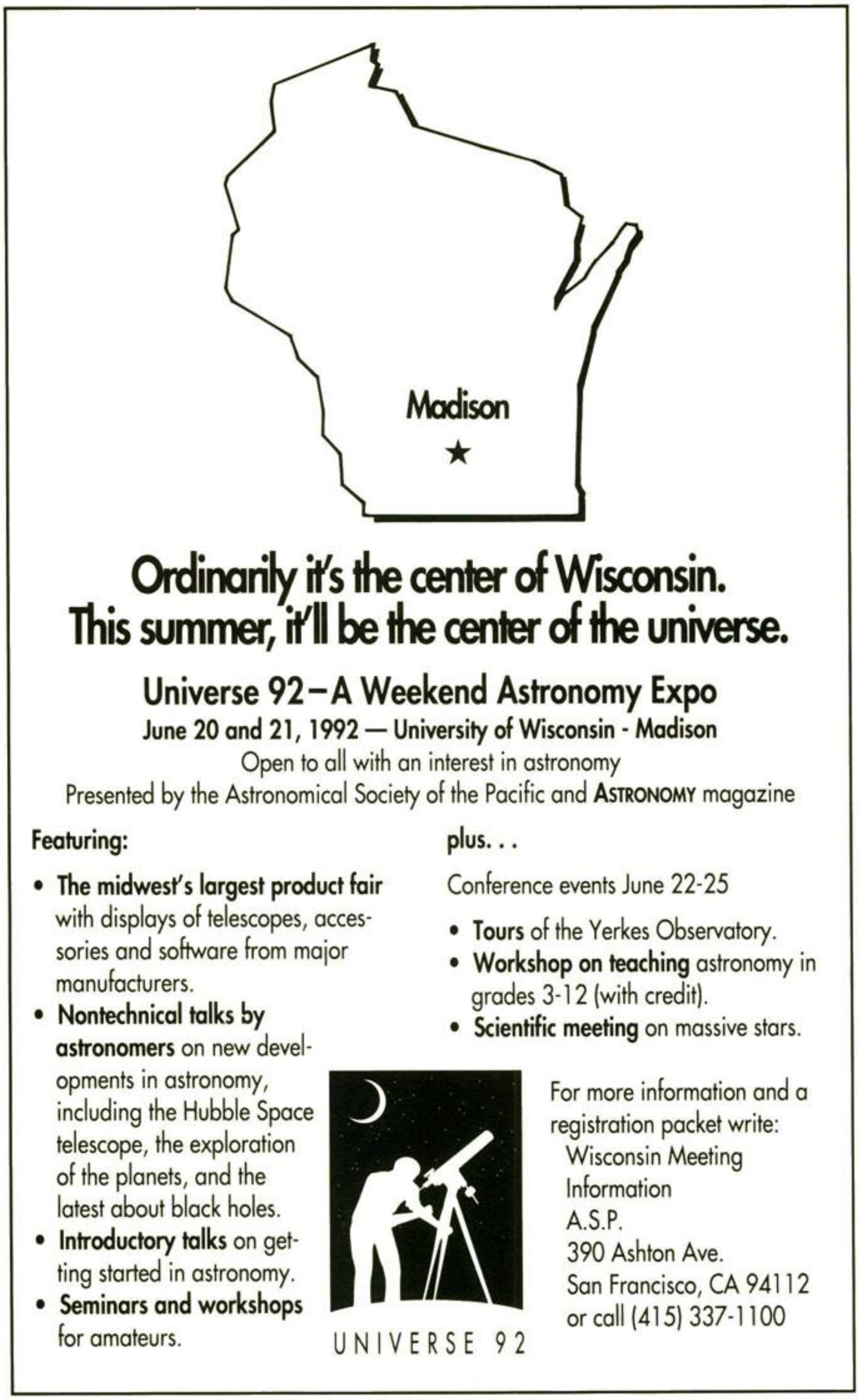
Planetary Exploration

Mars Beckons, by John Noble Wilford, (Vintage, 1991), ISBN 0-679-73531-3, 245 pages, paperback, $12.

It sure does. This is the paperback edition of a work originally published in 1990. As Wilford notes in a new preface dated August 1991, geopolitical events, chiefly in the former Soviet Union, have overtaken the book in some respects. For example, the grand plan of dovetailing U.S. and Soviet Mars missions will depend critically on how the government of the Russian Republic views the space program it has inherited. In this paperback edition, Wilford has let the original text stand, feeling that it provides a good overview of the scientific reasons for returning to Mars. Who will return and with what missions are all unanswered questions at present. But for the time being, this is still a good survey of a highly attractive target.

Mars Unfolds Space Atlas, (VanDam Publishers), ISBN 0-931141, folded maps in cover, $9.95.

Mars Unfolds is two maps of Mars packed into a folder. When you open the front part of the folder, you see two Martian hemisphere maps centered on the longitude meridians of 0° and 120°. The back part of the folder opens to show a Martian hemisphere centered on longitude 240° plus north and south polar views. The three hemisphere maps have a diameter of 8". In between the unfolding maps lie 18 pages of text, briefly outlining the planet's history in astronomy and astronautics. ☐



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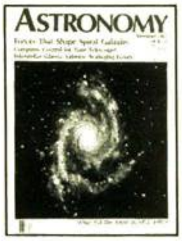

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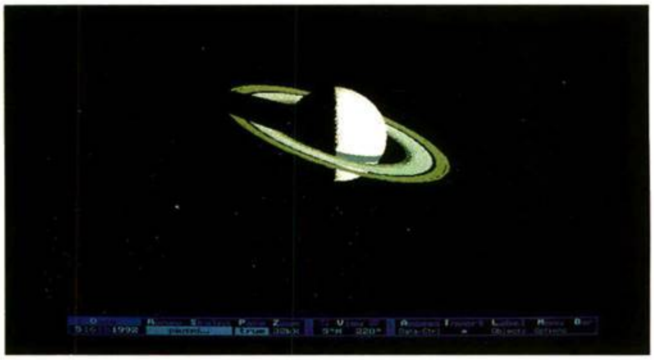
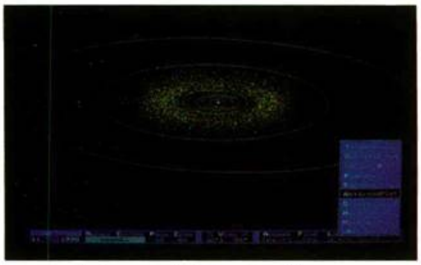


***Dance of the Planets (2.5)**, Applied Research and Consulting, Inc., P.O. Box 1955, Loveland, CO 80539. Phone (303) 667-1168. $195 plus shipping and handling. Registered users may upgrade to version 2.5 for $50 plus shipping and handling; 2.3 users can upgrade for the cost of shipping and handling. Minimum requirements: IBM PC/AT-compatible computer, 640 KB memory, EGA or higher, hard disk with 1.3 MB free space. Math coprocessor is recommended; mouse is optional. Available on 5¼" or 3½" diskettes.*



Dance plots over 4,900 asteroids

During the two years since our last look at this program (version 1.3, reviewed in the April 1990 issue), this powerful program became mightier, giving the user even more capability to explore the night sky. Dance is a planetarium program that depicts the positions of the stars and planets in the sky from anywhere on Earth. It is also an ephemeris program that predicts accurate planetary positions, times and locations of eclipses, and the positions of planetary satellites. And it is a simulator that calculates and displays the gravitational effects of the Sun and planets on the orbits of comets and asteroids.

Since our last review, the database of 1,500 stars has been expanded to 9,100, extending the brightness range to magnitude 6.5. Over 6,000 asteroids and comets may be viewed as well as roughly 1,400 other objects, including galaxies, star clusters, pulsars, and quasars. The program now displays the sky for dates between 4680 B.C. and A.D. 10,000.

New features include the plotting of the ecliptic across the sky, mapping of objects across an extended celestial sphere (called Skymaps), plotting of local horizons and the zenith, an improved planet ephemeris, and a listing of user-selectable observing sites. Not only does the program show occultations of the satellites of Jupiter, but it also shows the transits — sorry, no satellite shadows — and eclipses. One notable feature, 3-D stereo plotting of the orbits, is no longer available with the program. The program also now requires a hard disk.

The program still operates from a menu bar at the bottom of the screen. Key strokes or a mouse access the functions displayed in the bar, but it takes some practice before one is proficient in using this feature-rich program. The program designers seem to appreciate the difficulty in getting started with this program, because they include a tutorial of 40 sample sessions. These tutorial sessions show the new user how to use the program with specific astronomical examples.

The manual is now bound instead of contained in a three-ring binder. It is well-organized and includes an index. In addition to instructions on running the program, the book describes many sky events and fascinating gravitational encounters. And for the curious, it also includes a discussion of the method used to calculate orbits.

I have been a long-time fan of Dance and always enjoy setting Saturn at the center of the screen and zooming in until the rings are displayed. As time steps forward, the rings show their changing tilt as observed from Earth over Saturn's 29-year orbital period, with many intricate motions as Earth passes above and below Saturn's ring plane. You can even change the observing location to outside the solar system for a different view of Saturn's shadow on the rings. My only complaint about the program is that it doesn't display digital hours and minutes for the date. A better time display would enhance the simulations of satellite eclipses and other events.

Dance of the Planets remains one of the premier astronomical programs. It is versatile as a sky-mapper and powerful as an ephemeris and orbital simulator. If you like to explore the motions of planets, asteroids, or comets, you'll want to have this program. — *Dave Bruning*

NEW PRODUCTS

Orbits: Voyage Through the Solar System, *Software Marketing Corporation, 9831 S. 51st Street, Suite C-113, Phoenix, AZ 85044. Phone (602) 893-2400. $59.95. Minimum requirements: IBM PC-compatible computer, 512 KB free memory, MS-DOS 2.0 or higher, EGA or higher; mouse is optional. Both 5¹/4" and 3¹/2" diskettes are provided.*

Orbits brings the solar system to your PC through a combination of graphical images and text. Animated sequences show the orbital motions of the planets, simulate eclipses and nuclear energy generation in the Sun, and demonstrate the effects of gravity upon a traveler to other planets. The user can learn about the physical characteristics and internal structure of each planet and about the orbits of Earth satellites.

AstroPix, *Darrell Smith and Larry Tadlock, 305 W. King Street, Pottstown, PA 19464. $24.95 (plus $3.00 shipping and handling). Minimum requirement: IBM PC-compatible computer.*

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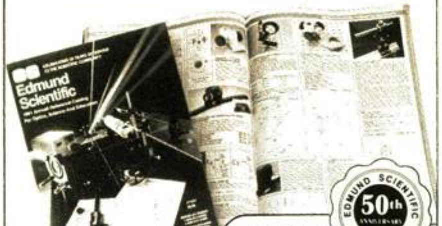

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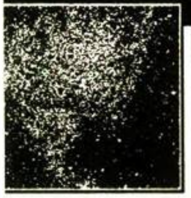

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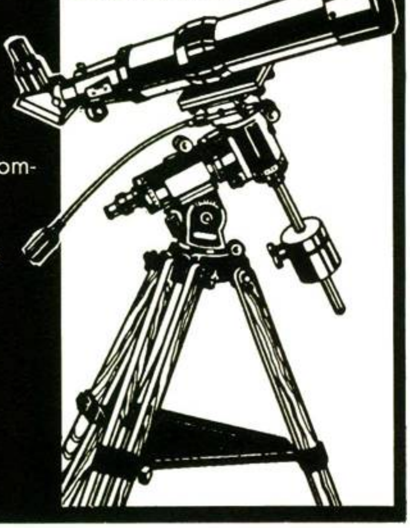

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2045S 4" SPOTTING SCOPE .. 429
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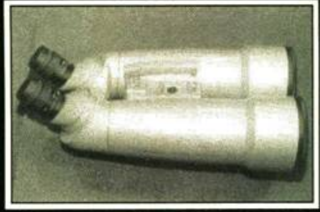

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New Astronomy Products

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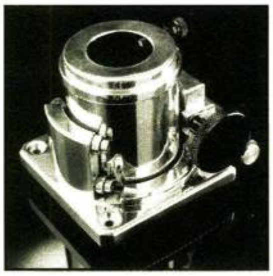
New Meade ED/APO refractors are available in four apertures: 4, 5, 6, and 7 inches. Each includes an f/9 multi-coated objective lens of ED (Extra-low Dispersion) glass that yields apochromatic, high-resolution optical performance. Optical tubes include 10 or more internal field stops to eliminate stray light, ensuring high contrast. The standard focuser has a 2.7-inch inside diameter, permitting the attachment of medium-format cameras.

The 4- and 5-inch models are supplied on the new LXD 600 German-type equatorial mount and standard field tripod; the 6- and 7-inch models include the larger LXD 700 mount and giant field tripod. Both mounts feature four sealed ball bearings on each axis, worm gear drives, and manual slow-motion controls. Two optional electronic drive systems, both of which include the Meade Smart Drive™ periodic error corrector, attach internally to any Meade APO model — the less expensive #1664 permits dual-axis tracking at two speeds (2x and 32x); the more advanced #1697 Computer Drive System includes four dual-axis speeds (2x, 32x, 2° per second, and 8° per second), all accessible through the handheld keypad. The #1697 also includes a GO TO capability — input the RA and Dec of an object, press GO TO, and the scope slews to the object.

Meade Instruments Corporation, 1675 Toronto Way, Costa Mesa, CA 92626, (714) 556-2291, FAX (714) 556-4604. Suggested national mail order prices: 4-inch model 102ED: $1,795; 5-inch model 127ED: $2,295; 6-inch model 152ED: $3,995; 7-inch model 178ED: $4,995.

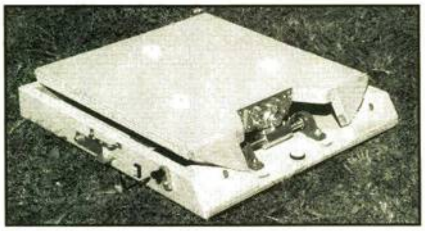


2 Crayford Focusers from Jim's Mobile

Originally designed by members of the Crayford Manor House Astronomical Society in the United Kingdom, the Crayford focuser uses ball bearings and a friction drive to provide reduced mechanical play. This design is now available commercially in the NGF-1 and NGF-2 focusers. Both models are machined from solid aluminum and have a side play that is claimed to be 1/100th the amount found in other focusers. The NGF focusers accommodate 2-inch eyepieces and feature a low 1.6-inch profile with 1.875 inches of focus travel. They are available with optional Motofocus electric focusing motors. As an additional enhancement the NGF-1 uses roller bearings on its drive shaft. The standard finish is black anodizing, but the NGF-1 can be ordered in a limited edition polished aluminum finish.

Jim's Mobile Incorporated, 1960 County Road 23, Evergreen, CO 80439, (303) 277-0304, FAX (303) 526-9140. NGF-1 (black or polished aluminum): $229; NGF-2 (black only): $169. Optional focusing motor for either: $70.

3 Tracking Platforms for Dobsonians

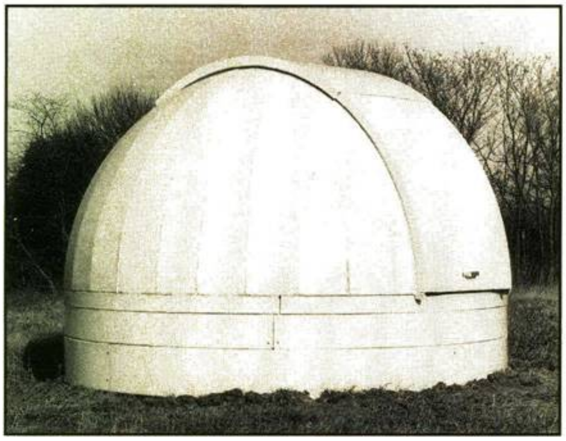


Equatorial Platforms has introduced a line of upgraded polar disk tracking platforms for Dobsonian telescopes of all sizes. Each custom-made platform provides an hour of motorized tracking with a quick rewind. The stepper motor drive system includes a hand controller for fine adjustment of the tracking rate and is powered by a 12-volt battery. Options include a two-speed right ascension motion for photographic guiding and visual centering and a dual-axis drive which allows fine guiding in declination.

Equatorial Platforms, 11065 Peaceful Valley Road, Nevada City, CA 95959, (916) 265-3183. Platform prices: for 10- to 15-inch scopes: $1,160; 16- to 18-inch: $1,490; 20- to 22-inch: $1,820; 24- to 26-inch: $2,480. Send $2 for an illustrated brochure.

4 Observatory Dome for Home Installation

Called the Home Dome, this 10-foot-diameter observatory dome fills the market gap between portable shelters and expensive professional observatory domes. The Home Dome is constructed entirely of molded fiberglass and features a 36-inch-wide viewing slot with two shutters that slide up and over the zenith, nesting on the back of the dome. The basic model is not motorized, but electric shutter and dome rotation mechanisms can be added as options. The one-foot-high base ring is bolted to a structure the buyer provides — a concrete block foundation, a shed, or a section of a house.

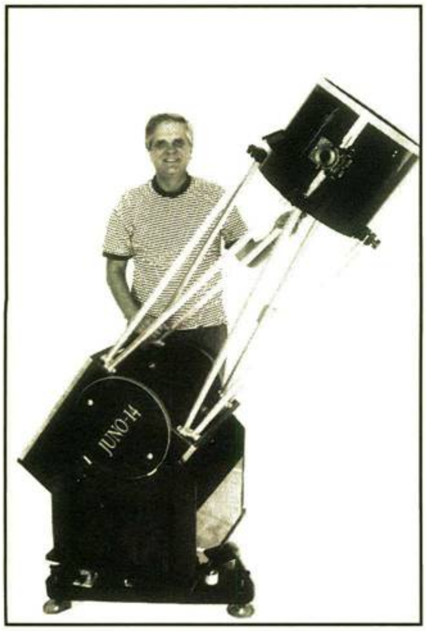


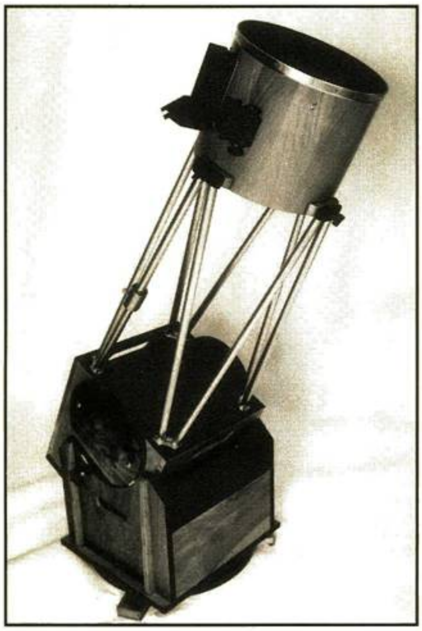
Technical Innovations, 22500 Old 100 Road, Barnesville, MD 20838, (301) 972-8040. Introductory price: $3,000 until April 30; $3,750 after April 30. Kit includes dome, shutters, base ring, installation hardware, and instructions. Call or write for free brochure.

5 Juno 15 Telescope

The Juno-15 (a 15-inch f/4.5 Newtonian) is now available in a choice of two finishes: the traditional marine finish in navy blue (left) and a new wood-grain finish (right) coated with clear polyurethane. Both models are available as standard Dobsonians or equipped with a custom-made equatorial platform that provides an hour of tracking. Both models also feature optics made by Richard Fagin who hand-figures each mirror. The Jupiter Telescope Company guarantees a 1/8-wave surface accuracy on the primary (1/4-wavefront error) and 1/10-wave surface accuracy on the secondary.

Jupiter Telescope Company, Inc., 810 Saturn Street, Suite 16, Jupiter, FL 33477, (407) 694-1154. Juno-15 with equatorial platform and wood grain finish: $4,795; without platform: $3,295. Blue marine finish: $285 extra. Tracking platform available separately for $1,595. Other optional accessories available — call or write for brochure.





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Meetings & Events

April 29 - May 2
Middle Atlantic Planetarium Society Conference, Carnegie Science Center, Pittsburgh, Pennsylvania. Phone: (412) 237-3308.

May 6
Webb Society Annual General Meeting, Cambridge, England. Contact: B. J. McInnerny, 14 Heathfield Avenue, Poole, Dorset BH12 5DJ. Phone: (0202) 521812.

May 9
Astronomy Day. Contact: Gary Tomlinson, Astronomy Day Coordinator, Public Museum of Grand Rapids, 54 Jefferson SE, Grand Rapids, MI 49503. Phone: (616) 456-3987.

May 9
Astronomy Day, Peace Valley Nature Center, near Doylestown, Pennsylvania. Contact: Alan Pasicznyk at (215) 348-2385.

May 9
Astronomy Day, North Shore of Boston, Massachusetts. Sponsored by the North Shore Amateur Astronomy Club. Contact: Paul Graveline, 9 Stirling Street, Andover, MA 01810-1408. Phone: (508) 470-1971.

May 9
Astronomy Day celebration, Charles Hayden Planetarium, Boston, Massachusetts. Contact: Noreen A. Grice, Education Coordinator, Charles Hayden Planetarium, Boston Museum of Science, Boston, MA 02114. Phone: (617) 589-0270.

May 9
Custer Institute Family Astronomy Day, Southold, New York. Contact: Warren Hamburger at (516) 888-0072 or Barbara Lebkuecher at (516) 722-3850.

May 15-16
Northwest Oklahoma Star Party, Enid, Oklahoma. Contact: Northwest Oklahoma Astronomy Club, 1719 Pawnee, Enid, OK 73703. Phone: Dan Matthews at (405) 233-5707.

May 20-22
International Amateur-Professional Photoelectric Photometry Big Bear Symposium. Contact: Bob Jones, P. O. Box 2203, Running Springs, CA 92382.

June 5-12
Beginning Astronomy Camp for Teens, Tucson, Arizona. Sponsored by The

University of Arizona's Alumni Association and Steward Observatory. Contact: Lisa Roubal or Kim Dow, Arizona Alumni Association, 1111 North Cherry, Tucson, AZ 85721. Phone: (800) 232-8278 (outside Arizona), or (602) 621-5233.

June 24 - July 7
Summer Program at Mount Wilson for undergraduate physics or astronomy majors, Los Angeles, California. Sponsored by the Consortium for Undergraduate Research and Education in Astronomy at Mount Wilson Observatory. Contact (by April 24): Joseph L. Snider, Department of Physics, Oberlin College, Oberlin, OH 44074. Phone: (216) 775-8335.

June 19-26
Advanced Astronomy Camp for Teens, Tucson, Arizona. Contact: Lisa Roubal or Kim Dow (see June 5-12 entry).

June 23-24
The Universe in the Classroom, University of Wisconsin, Madison, Wisconsin. Contact: Astronomical Society of the Pacific, Teachers' Workshop Information, 390 Ashton Avenue, San Francisco, CA 94112.

August 27-30
2nd Annual Great Plains Star Party, Flint Hills, 75 miles southwest of Kansas City, Kansas. Sponsored by the Kansas Astrophotographers and Observers Society. Contact: Bob Nederman, 9200 Westbrooke Drive, Overland Park, KS 66214. Phone: (800) 473-4382.

August 29
Summer Star Party, Strawberry Mountain, Ohio. Sponsored by the Black River Astronomical Society. Contact: Mike Harkey, 1631 Maple Drive, Lorain, OH 44052. Phone: (216) 288-8556.

September 18-21
Meeting of European (and International) Planetary and Cometary Observers, Violau, Germany. Contact: Wolfgang Meyer, Martinstrasse 1, D-(W)1000 Berlin 41, Germany. ☐

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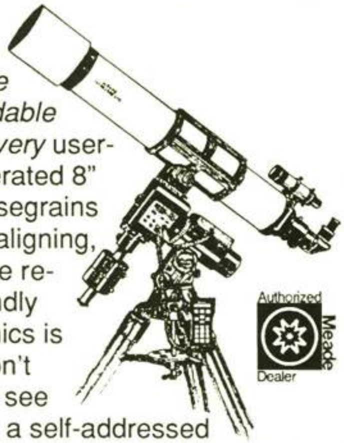

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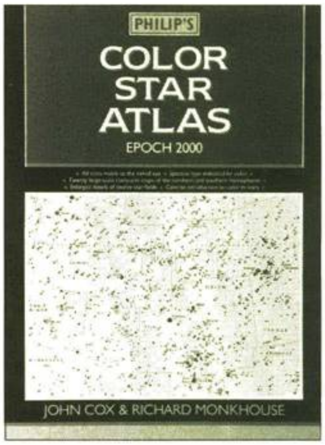

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Readings & Resources

To the Edge (page 34)
Pioneering the Space Frontier; the report of the national commission on space. (Bantam Books, 1986). An overall view of what America might do in space exploration over the coming decades, this volume includes material on future Pluto and Neptune missions.

Unfolding Mysteries of Stellar Cycles (page 42)
"The Rise and Fall of the Sun's Activity" by Jeff Kanipe, Richard Talcott, and Robert Burnham, ASTRONOMY, October 1988. A discussion of ground-based and space observations that show that the Sun changes in brightness during its 11-year sunspot cycle.

"Looking Inside the Sun" by James LoPresto, ASTRONOMY, March 1989. Describes solar oscillations and how astronomers use them to probe the interior of the Sun, study its internal rotation rate, and learn about possible connections to solar brightness changes.

Life Around a Larger Sun (page 50)
"The Earth Without a Moon" (February 1991), "Life Near the Center of the Galaxy" (April 1991), and "Seeing the World Through Infrared Eyes" (June 1991), all by Neil F. Comins. Three other thought-provoking articles in the "what if" series.

Polar Aligning Your Telescope (page 68)
All about Telescopes by Sam Brown, (Edmund Scientific Co., 1975). This cartoon-illustrated book provides a wealth of information on telescope use and maintenance, including polar alignment.

Watching Halley's Debris (page 78)
Meteor Showers: A Descriptive Catalog by Gary W. Kronk (Enslow Publishers, Inc., 1988). Facts, figures, and observational histories of dozens of meteor showers. A must for meteor fans.

Observe Meteors by David H. Levy and Stephen J. Edberg, (Astronomical League, 1986). An excellent booklet authored by two well-known astronomers who explain how to conduct an organized meteor watch.

Building Owl Observatory (page 82)
"Build a Backyard Observatory" by Steven Chomniak, ASTRONOMY, June 1989. This simple observatory features a roll-off roof and can be built in several weekends.

How to Build Your Own Observatory reprinted from issues of *Telescope Making* magazine (Kalmbach Publishing Co., 1988). This do-it-yourself guide features seventeen observatories, from simple shelters to roof-top structures.

CREDITS

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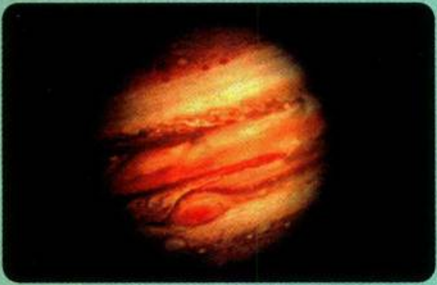

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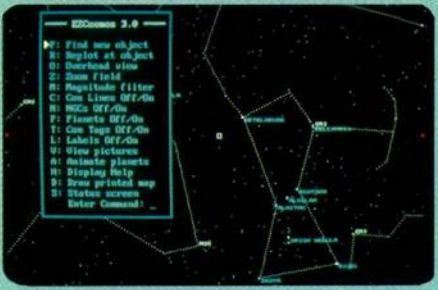
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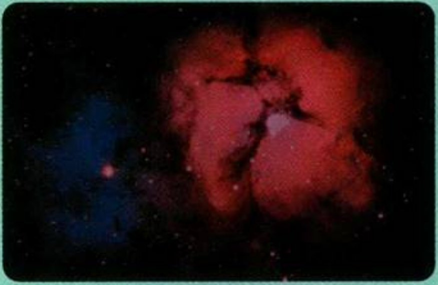

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COMING IN THE JUNE 1992 ISSUE OF ASTRONOMY

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EXTRASOLAR PLANETS Though the first planet found orbiting a pulsar proved illusory, a second set of pulsar planets appears compelling.

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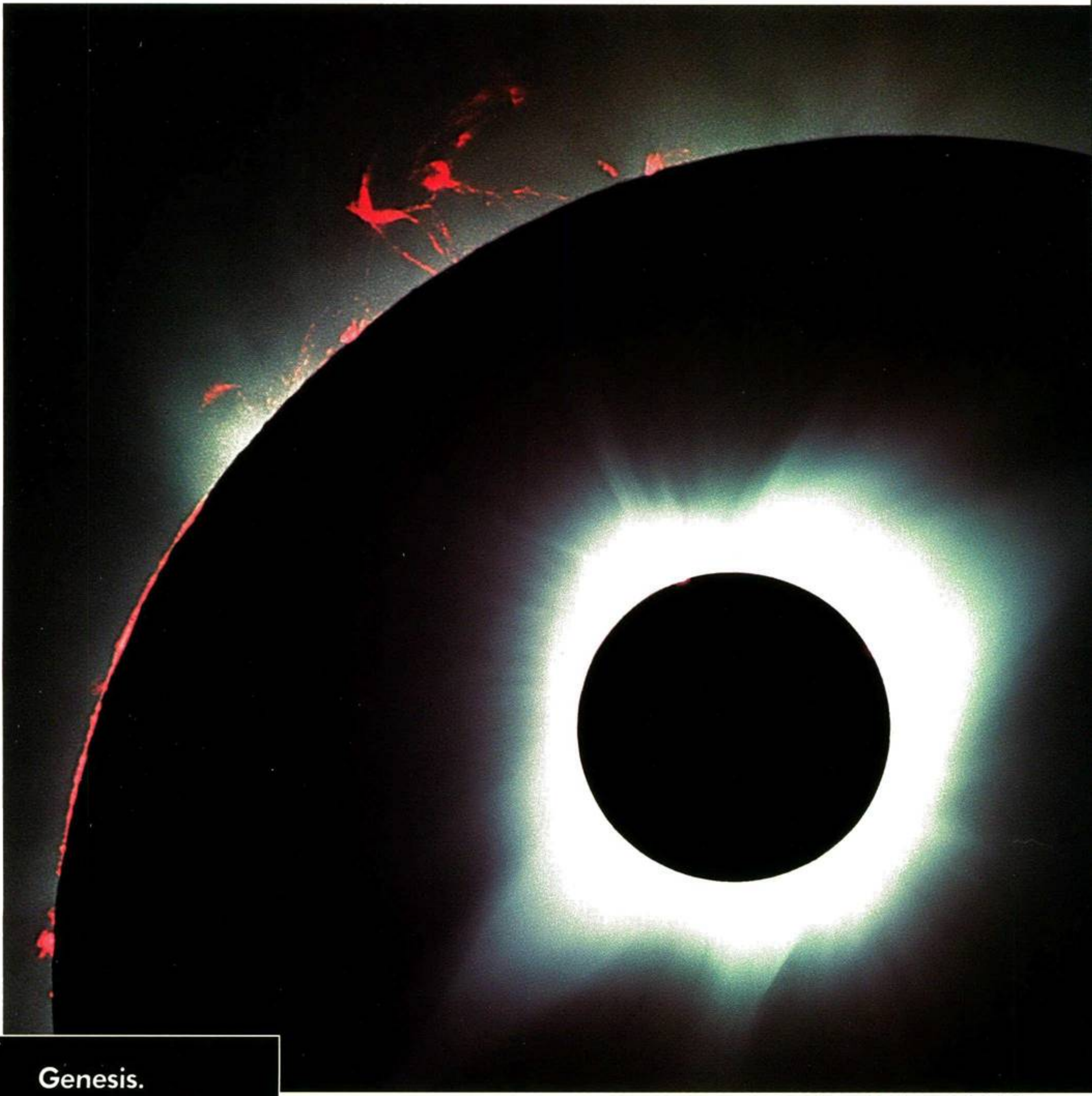

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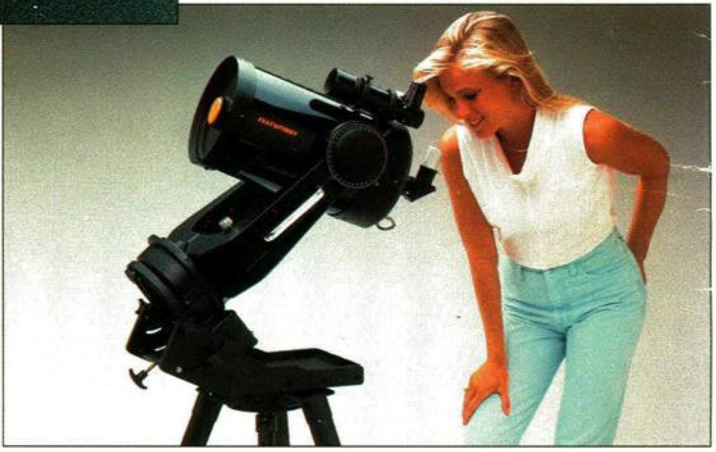

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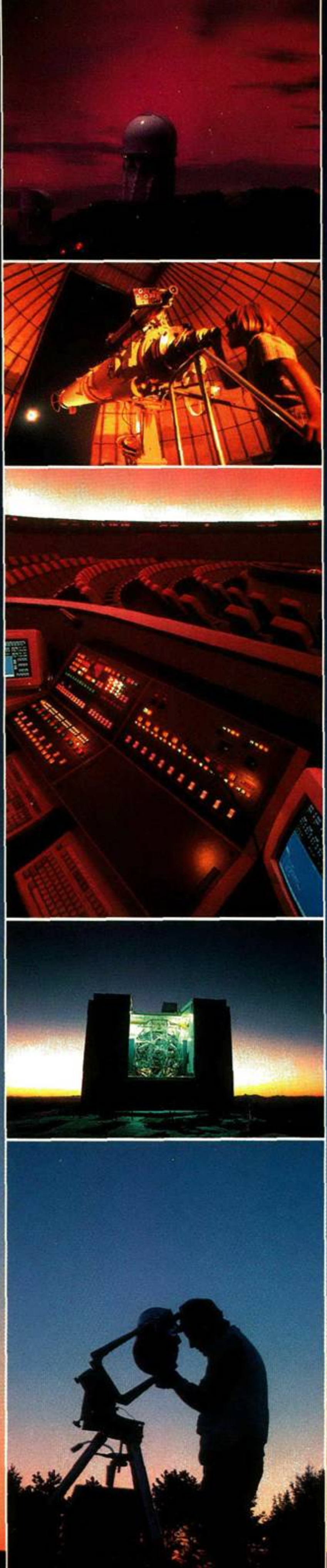

1992
ASTRONOMY DIRECTORY

Supplement to

ASTRONOMY magazine

Your guide to North America's astronomy clubs, organizations, planetariums, and observatories.

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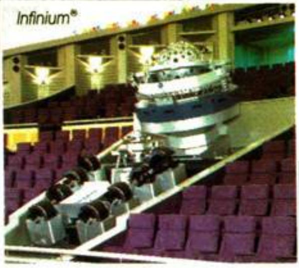
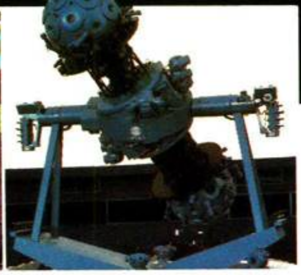
To fully appreciate how real our sky looks, take a closer look.





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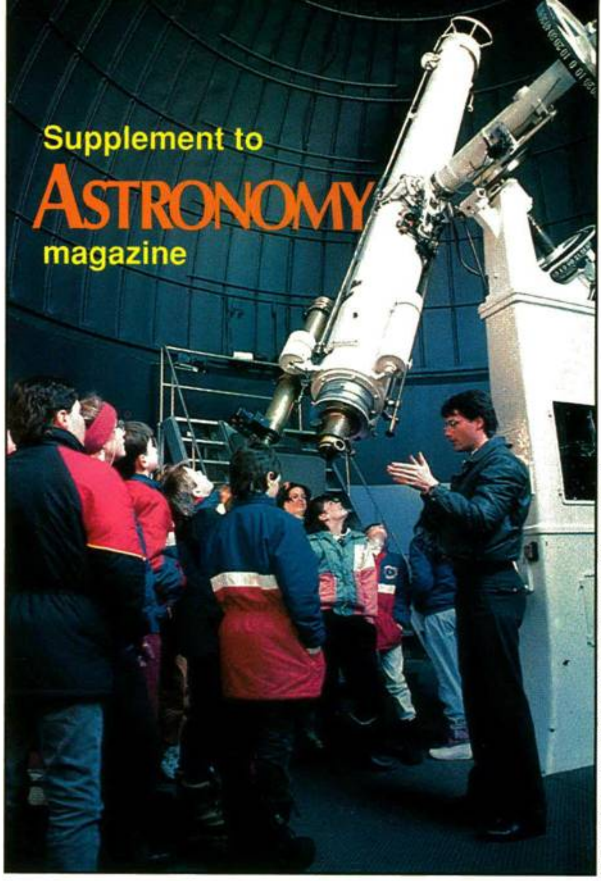

Supplement to ASTRONOMY magazine

National Musuem of Science and Technology, Ottawa, Canada.

ASTRONOMY CLUBS

Over 36,000 amateur astronomers in North America belong to local or regional astronomy clubs. Clubs provide expert advice, instructional courses and meetings, access to libraries, telescopes, and observatories, and lots of comraderie with people who share a love of the stars. Many clubs hold regular public viewing nights and star parties for area amateurs. These are often held at local planetariums or parks, or at observatories operated by the individual clubs.

Our listing contains over 480 clubs in North America. Why not scan down the list and give your local club a call to find out what they have planned for activities this year. Even if you choose not to join a club, you may still find attending one of their events a great way to expand your hobby.

If your local club is not included on our list, please contact us so we can update our database.

UNITED STATES

ALABAMA

Auburn: Auburn Astronomical Society, 748 E. Magnolia Ave., 36830, Jim Chestnutt, (205) 821-1062, 20 members.

Birmingham: Birmingham Astronomical Society, P.O. Box 36311, 35236, Gregory Robinson, (205) 668-1559. Founded 1977, 130 members, observatory with 16" scope.

Huntsville: Von Braun Astronomical Society, Box 1142, 35807, Dennis Culver, (205) 882-2508. Founded 1954, 150 members, observatory with 18" scope. Monthly public viewing nights.

Mobile: Mobile Astronomical Society, P.O. Box 160972, 36616-1972, Leland Cox, (205) 633-9079. Founded 1983, 25 members, observatory with 12.5" reflector. Public viewing nights.

Rainbow City: Southside Astronomy Club, 103 Eddie Circle, 35901, Julian Long, (205) 442-7169.

Tuscumbia: Muscle Shoals Astronomical Society, 302 N.E. Commons, 35674, Homer Russell, Jr., (205) 383-6717. Founded 1959, 13 members, observatory with 10" Springfield reflector. Public viewing nights.

ALASKA

Anchorage: Anchorage Astronomical Society, 3539 Dunkirk Dr., 99502, John Morrow, (907) 269-5744.

Fairbanks: Astronomical Units, Box 82210, 99708, Robert E. Fischer, (907) 456-6586. Founded 1986, 15 members, observatory with 14" SCT.

AMERICAN SAMOA

Pago Pago: American Samoa Astronomical Society, P.O. Box 3076, 96799.

ARIZONA

Grand Canyon: Astronomical Society of the Grand Canyon, P.O. Box 1515, 86023, Larry Noon, (602) 638-2263.

Mesa: Leisure World Astronomers, 1792 Leisure World, 85206, Bud Ridley, (602) 981-3136.

Phoenix: Phoenix Astronomical Society, 518 West Coronado Rd., 85003, Kai Staats, (602) 253-3077. Founded 1948, 50 members.

Phoenix: Phoenix Youth Astronomical Network, 3744 W. Brown, 85051, J. Barentine. Founded 1990, 8 members.

Phoenix: Saguaro Astronomy Club, 210 W. Tierra Buena Lane, 85023, Paul Lind, (602) 863-3077. Founded 1977, 130 members.

Prescott: Prescott Astronomy Club, 1848 Emerald Dr., 86301.

Scottsdale: East Valley Astronomy Club, 8407 N. 86th Way, 85258, Frank Kraljic, Jr., (602) 991-5105. Founded 1987, 90 members. Hosting Meteorite Hunt for members and special guests only.

Sedona: Verde Valley Astronomy Club, 115 Whitehorse Way, 86336, Barbara Westhafer, (602) 284-9167. Founded 1988, 25 members. Hosts star show at Verde River Days Celebration.

Sierra Vista: Huachuca Astronomy Club, 3395 Briarwood Dr., 85635, Ray Perger, 20 members.

Sun City West: Astronomy Club of Sun City West, 17802 N. 131st Avenue, 85375, Jim Crisman, (602) 584-0896. Founded 1985, 140 members.

Tucson: Tucson Amateur Astronomy Association, 10385 Observatory Dr., 85747, Derald Nye. Founded 1954, 138 members.

ARKANSAS

Arkadelphia: Ark-La-Tex Skywatchers, P.O. Box 493, 71923, Rex McDaniel. Founded 1984, 26 members.

Dover: Arkansas Amateur Astronomers, 20 Rolling Green Dr., P.O. Box 261, 72837, Rex McDaniel, (501) 331-4868. Founded 1991, 10 members, observatory with 13" scope. Public viewing nights. Hosts Mt. Magazine Star Party Aug. 28-29.

Fayetteville: Astronomical Society of Northwest Arkansas, 2503 Sweetbriar Dr., 72703, Betty Davis, (501) 442-2833. Founded 1979, 30 members. Public= viewing nights.

Fort Smith: Arkansas-Oklahoma Astronomical Society,

CLUBS

P.O. Box 31, 72902, Joe Roam, (501) 474-4740. Founded 1985, 30 members, observatory with 29" Newtonian. Hosts annual Arkansas Star Party.

Hot Springs Village: Village Star Gazers, 13 Tarifa Lane, 71901, Dorothy Kegerreis, (501) 922-3068. Founded 1990, 16 members.

Roland: Mid-South Astronomical Society, P.O. Box 38, 72135-0038, Bruce McMath, (501) 372-1367. Founded 1970, 35 members, observatory with 12.5" scope.

Texarkana: Red River Astronomy Club, 4808 Sunbury, 75502, Ken White, (501) 772-4200. Founded 1985, 10 members.

CALIFORNIA

Apple Valley: High Desert Astronomical Society, P.O. Box 2968, 92307, Laurie Allen, (619) 949-3077. Founded 1990, 75 members, observatory with 14" SCT. Public viewing nights.

Aptos: Cabrillo Astronomical Stargazing Society, Cabrillo College, 6500 Soquel Dr., 95003. Founded 1985, 24 members. Monthly star parties at Cabrillo College Observatory.

Arcata: Arcata Society for Amateur Astronomers, 3211 Alice Ave., 95521.

Bakersfield: Kern Astronomical Society, 1811 Forrest St., 93304, Charles Brown, (805) 322-6496. Founded 1973, 44 members.

Berkeley: Sidewalk Astronomers, P.O. Box 10003, 94709, Gerald Pardeilhan, (415) 527-4026.

Big Bear Lake: Bear Valley Astronomical Society, P.O. Box 874, 92314, Also the contact for Stony Ridge Observatory.

Chatsworth: Celestial Observers, 9534 Gierson Ave., 91311-4737, Michael Selden, (818) 882-6172. Founded 1975, 12 members.

Costa Mesa: Orange County Astronomers, 2195 Raleigh Ave., 92627, John Sanford, (714) 722-7900. Founded 1967, 610 members, observatory with 22" Cassegrain. Hosts Astronomy Days at Orange County Fair.

Eureka: Astronomers of Humboldt, P.O. Box 351, 95502, Robert Zigler, (707) 768-3296. Founded 1957, 25 members.

Fallbrook: Oceanside Photo and Telescope Astronomical Society, 929 Buena Rosa Ct., 92028, Penny Hauck, (619) 723-0684. Founded 1984, 170 members. Hosts annual Oceanside Star Party.

Fresno: Central Valley Astronomers, 5790 East Tarpey Ave., 93727, Clarence Funk, (209) 291-7879. Founded 1952, 120 members, 20" portable telescope. Monthly public star parties.

Glen Ellen: Valley of the Moon Astronomical Society, P.O. Box 999, 95442, Al Heppe, (707) 996-1246.

Hemet: Hemet Astronomical Society, 561 West Devonshire Ave., 92343, Ralph L. Shook, (714) 658-3631.

Idyllwild: Idyll-Gazers Amateur Astronomy Club, P.O. Box 1245, 92549, Joe Neu, (714) 659-3562. Founded 1979, 70 members. Monthly star parties.

Joshua Tree: Andromeda Astronomical Society, Star Route 1, Box 1112, 92252, Bill Crawford. Founded 1976, 30 members. Monthly star parties at Joshua Tree National Monument.

Lake Arrowhead: Mountain Skies Astronomical Society, P.O. Box 1169, 92352, Ronald R. Vaughan, (714) 337-4075.

Lakewood: Excelsior Telescope Club, St. Pancratius Catholic Church, 3519 St. Pancratius Place, 90712, Fr. Ronald Royer, (213) 634-6111.

Lancaster: Antelope Valley Astronomical Soc., P.O. Box 426, 93534, Steve Mathis, (805) 256-4261.

Livermore: Tri-Valley Stargazers, P.O. Box 2476, 94551, Alan Gorski, (510) 828-3278. Founded 1979, 140 members, observatory with 17" scope. Hosting Astronomy Day Oct. 2, 1992.

Los Angeles: Los Angeles Astronomical Society, 2800 East Observatory Rd., 90027, Timothy Thompson, (213) 833-1733. Founded 1926, 350 members, observatory with 31" reflector.

Martinez: Mt. Diablo Astronomical Society, 1302 Roseann Dr., 94553, Ginger Todd, (415) 229-3914. Founded 1958, 60 members. Monthly star parties at Mt. Diablo Summit.

Mill Valley: Marin Stargazers, 27 Morning Sun, 94941.

Monterey: Monterey Institute for Research in Astronomy, P.O. Box 1551, 93941, Stew Hobson, (408) 373-7560. Founded 1983, 40 members. Public star parties.

Mountain View: Peninsula Astronomical Soc., P.O. Box 4542, 94040, Bill Sorrells, (415) 370-1215.

Murrieta: Temecula Valley Astronomers, 37795 Sea Pines Court, 92563, Kent Smith, (714) 698-0975. Founded 1989, 25 members. Monthly star parties.

Newhall: Local Group of Santa Clarita Valley, 25032 Walnut St., 91321, LaVerne Booth, (805) 259-3284. Founded 1984, 85 members.

Oakland: Chabot Telescope Makers Workshop, 4917 Mountain Blvd., 94619.

Oakland: Eastbay Astronomical Society, 4917 Mountain Blvd., 94619, Betty Neall, (510) 533-2394. Founded 1924, 200 members.

Palm Desert: Astronomical Society of the Desert, College of the Desert, 43-500 Monterey Ave., 92260, Ashley McDermott, (619) 346-2524. Founded 1972, 55 members. Public viewing nights.

Pasadena: Students for the Exploration and Development of Space, 112-58 Caltech, 91126, Jeff Foust, (818) 449-1345. Founded 1986, 105 members.

Ridgecrest: China Lake Astronomical Society, P.O. Box 1783, 93555, Bruce Churchill, (619) 375-7247. Founded 1958, 70 members.

Riverside: Riverside Astronomical Society, P.O. Box 51222, 92517-2222. Founded 1956, 100 members. 24-hour Hotline: (714) 689-0116. Hosts annual Riverside Telescope Makers Conference.

Rocklin: Sacramento Valley Astronomical Society, P.O. Box 575, 95677, Mark Uitti, (916) 878-2056. Founded 1945, 188 members, observatory with 16" Ritchey-Chretien scope.

San Anselmo: Tamalpais Astronomical Society, 31 Crane Dr., 94960.

San Bernardino: San Bernardino Amateur Astronomers, 1345 Garner Ave., 92411, David E. Garcia, (714) 884-0657. Founded 1958, 65 members. Owns 24" Newtonian.

San Diego: San Diego Astronomy Association, P.O. Box 23215, 92193, Greg Cade. Founded 1963, 320 members, observatory with 22" scope. Public viewing nights.

San Diego: San Diego L5 Society, P.O. Box 4636, 92164, Leonard McVicker. Founded 1982, 52 members.

San Francisco: S.T.A.R.S., City College of San Francisco, 50 Phelan Ave., 94112, Don Warren, (415) 239-3242. Founded 1950, 20 members, observatory with 14" SCT. Student club.

San Francisco: San Francisco Amateur Astronomers, c/o Morrison Planetarium, Golden Gate Park, 94118, Bob Levenson, (415) 750-7127. Founded 1952, 160 members, observatory with 25" scope. Monthly star parties on Mt. Tamalpais.

San Jose: Group 70/Large Amateur Telescope Project, 3509 Calico Ave., 95124, Jim Van Nuland, (408) 997-3347. Founded 1954, 400 members. Monthly star parties at Branham Lane City Park.

San Juan Bautista: Fremont Peak Observatory Association, P.O. Box 1110, 95045-1110, Rick Morales, (408) 623-2465. Founded 1985, 175 members, observatory with 30" reflector. Public observing nights.

San Luis Obispo: Central Coast Astronomical Society, P.O. Box 1415, 93406, Lee Coombs, (805) 466-2788. Founded 1969, 70 members.

San Marcos: Astronomical Society of Southern California, P.O. Box 2046, 92069, Michael Wartenberg, (619) 741-6128.

San Mateo: San Mateo Astronomical Society, P.O. Box 974, Station A, 94403, Bob Bruynesteyn, (415) 349-3743. Founded 1960, 50 members.

Santa Barbara: Santa Barbara Astronomy Club, P.O. Box 3702, 93130, Clyde Kirkpatrick, (805) 966-3695. Founded 1957, 52 members, observatory with 16.5" scope. Public viewing nights. Hosts Annual Star Party Aug. 15.

Santa Cruz: Santa Cruz Astronomy Club, L-2 San Carlos Lane, 95065, James M. Bricken, (408) 335-2450.

Santa Monica: Santa Monica Amateur Astronomy Club, 1415 Michigan Ave., 90404, Robert Lozano, (310) 450-1944. Founded 1981, 35 members. Open House Sept. 11, 1992.

Santa Rosa: Sonoma County Amateur Astronomers, P.O. Box 183, 95402, Ed Megill, (707) 795-7829. Founded 1980, 200 members, observatory with 20" scope. Public viewing nights. "Striking Sparks" Telescope Day May 9.

Simi Valley: Ventura County Astronomical Society, P.O. Box 982, 93062, Rick Williams, (805) 523-3066, 110 members.

Sonora: Omega-One, 21558 American River Dr., 95370, Lance Kearns. Founded 1985, 25 members, observatory with 13.1" scope. Public viewing nights. Hosts Globular and Open Cluster Hunt Aug. 1.

Stockton: Stockton Astronomical Society, P.O. Box 243, 95201, Ed Rible, (209) 478-5795. Founded 1950, 65 members.

Tulare: Tulare Astronomical Association, P.O. Box 515, 93275, Stanley H. Manro, (209) 685-0585. Founded 1967, 100 members. Operates Arthur Pursell Observatory/Visitor Center. Public viewing nights.

Upland: Pomona Valley Amateur Astronomers, P.O. Box 162, 91786, Harvard Pennington, (714) 983-7308, 200 members.

Van Nuys: Los Angeles Valley College Astronomy Club, 5800 Fulton Ave., 91401, Bruce Dale, (818) 781-1200. Founded 1985, 30 members.

Vandenberg AFC: Vandenberg Amateur Astronomical Society, P.O. Box 5321, 93437, Bob Karl, (805) 733-4390. Founded 1985, 20 members, observatory with 14" SCT. Public viewing nights.

Waterford: Stanislaus Amateur Astronomers, 12129 Washburn Ave., 95386, Howard Wilson, (209) 874-4313. Founded 1989, 35 members, observatory with 14" SCT. Monthly public viewing nights.

Whittier: Western Observatorium, 14517 E. Broadway, 90604, Roger Wilcox, (213) 941-9755. Founded 1975, 40 members. Hosts annual Telescope Users Clinic.

Woodland Hills: Polaris Astronomical Association, 22018 Ybarra Rd., 91364, Ray G. Coutchie, (818) 347-8922. Founded 1960, 40 members, observatory with 12" & 19" scopes.

COLORADO

Colorado Springs: Colorado Springs Astronomical Society, P.O. Box 62022, 80962, Jim Lawrence, (719) 593-0801. Founded 1985, 50 members. Hosts annual Summer Star Stare.

Colorado Springs: Rocky Mountain Astrophysical Group, 12815 Porcupine Lane, 80908, Paul Van Slyke, (719) 495-3828. Founded 1987, 100 members. Operates Black Forest Observatory (30" scope), a non-profit educational facility.

Denver: Denver Astronomical Society, c/o Chamberlain Observatory, 2930 E. Warren Ave., 80210, Dave Trott, (303) 871-5172. Founded 1947, 150 members, Chamberlain Observatory (20" Clark refractor).

Elbert: High Plains Astronomy Club, 13265 Bozeman Trail, 80106, Mike Silva, (719) 495-0873. Founded 1990, 8 members, observatory with 11" scope. Public viewing nights.

Grand Junction: Western Colorado Astronomy Club, P.O. Box 55032, 81505, Marvin R. Dershem, (303) 242-1351. Founded 1989, 35 members.

Longmont: Longmont Astronomical Society, P.O. Box 8029, 80501, Bob Spohn, (303) 772-1470. Founded 1986, 40 members.

Pueblo: Southern Colorado Astronomical Association, 2801 8th Ave., 81003, Mike Bosley, 6 members.

CONNECTICUT

New Haven: Astronomical Society of New Haven, P.O. Box 3005, 06515, Linda Marks, (203) 874-4816. Founded 1937, 81 members, observatory with 10" scope. Monthly public star parties. Hosts Connecticut Star Party.

Oakdale: Thames Astronomical Society, 55 Doyle Rd., 06370, Kathleen Audette, (203) 859-0071. Founded 1974, 23 members.

Stamford: Fairfield County Astronomical Society, Stamford Museum Observatory, 39 Scofieldtown Rd., 06903, Charles Scovil, (203) 322-1648. Founded 1954, 76 members, observatory with 22" Maksutov.

Stratford: Boothe Astronomical Society, 114 Kings College Place, 06497, Vincent Manjoney, (203) 375-9673. Founded 1952, 20 members, observatory with 16" scope. Public viewing nights.

Torrington: Litchfield Hills Amateur Astronomy Club, 361 Funston Ave., 06790, David H. Wheeler, (203) 489-8898. Founded 1956, 23 members. Monthly star parties.

Waterbury: Mattatuck Astronomical Society, Mattatuck Community College, 750 Chase Parkway, 06708, J. Lawrence Pond, (203) 575-8236. Founded 1985, 78 members, observatory with 14" SCT. Public viewing nights.

West Hartford: Astronomical Society of Greater Hartford, Gengras Planetarium, 950 Trout Brook Dr., 06119, Jay Sottolano, (203) 651-0096. Founded 1955, 160 members.

Westport: Westport Astronomical Society, P.O. Box 5118, 06881-5118, Bob Deedan, (203) 226-8812. Founded 1975, 70 members, observatory with 12.5" scope. Public nights every Wed.

DELAWARE

Wilmington: Delaware Astronomical Society, P.O. Box 652, 19899.

Wilmington: Mount Cuba Astronomical Observatory Inc., P.O. Box 3915, Hillside Hill Rd., Greenville, 19807, Grace Quirk, (302) 654-6407. Founded 1958, 300 members, observatory with 24" telescope. Public viewing nights, and children's camps.

FLORIDA

Bradenton: Local Group of Deep-Sky Observers, 2311 23rd Avenue West, 34205, Vic and Lynne Menard, (813) 747-8334. Founded 1983, 100 members.

Branford: Alachua Astronomy Club, Route 3, Box 98, 32008, Gilbert Bernardo, (904) 935-0340. Founded 1987, 36 members.

Callahan: Callahan Astronomical Society, Route 3, Box 1062, 32011.

Cocoa: Brevard Astronomical Society, P.O. Box 1084, 32923, Tom Olsen, (407) 725-2451. Founded 1971, 30 members.

Englewood: Lemon Bay Astronomy Club, Lemon Bay High School, 2201 Placida Rd., 34223, Frank Lock. Founded 1990, 30 members. Open to high school students only.

Fort Lauderdale: South Florida Amateur Astronomers Association, 16001 West State Rd. 84, 33326, Phil Hauger, (305)721-4159. Founded 1966, 70 members. Public nights at Fox Observatory (12.5" scope) every 2nd and 4th Sat.

Ft. Myers: Southwest Florida Astronomical Society, P.O. Box 6583, Miracle Mile Station, 33911-6583, Alan Goldman, (813) 495-2000. Founded 1980, 40 members.

Fort Pierce: Treasure Coast Astronomical Society, 131 Queen Catherina Ct., 34949, Walter Swentzell, (407) 465-4454. Founded 1983, 30 members.

Jacksonville: Northeast Florida Astronomical Society, P.O. Box 16574, 32245-7338, Harold Carney, (904) 645-9310. Founded 1972, 50 members, observatory with 14.25" Newtonian-Cassegrain. Public viewing nights.

Largo: Tampa Area Astronomy Society, 9890 82nd St. N., 34647, John Novak, (813) 392-4699. Founded 1951, 45 members, observatory with 20" reflector.

Melbourne: Indian River Astronomical Society, 1201 Sunnypoint Dr., 32935.

Melbourne: Society for Astronomy and Space Sciences, Florida Institute of Technology, Physics/Space Science Dept., 32901-6988, Michael Adams, (407) 768-8000, 40 members, observatory with 14" SCT.

Miami: Belen Jesuit Prep School Astronomy Club, 500 SW 127th Ave., 33184, Leo Nunez, (305) 223-8600. Founded 1979, 30 members, observatory with 8" scope. Bimonthly public viewing nights.

Miami: Southern Cross Astronomical Society (Miami), 13841 SW 106 St., 33186, Barbara Yager, (305) 661-1375. Founded 1922, 287 members, observatory with 14" SCT. Public viewing nights.

Naples: Everglades Astronomical Society, 780-C Meadowland Dr., 33963, Peter Wlasuk, (813) 597-5088. Founded 1980, 50 members. Public viewing nights.

Orlando: Central Florida Astronomical Society, 810 East Rollins St., 32803, Charles Finnigan, (407) 657-4347. Founded 1964, 125 members.

Palm Beach Gardens: Astronomical Society of the Palm Beaches, P.O. Box 30023, 33420, Elizabeth Long, (407) 746-8064, 76 members. Monthly public viewing nights.

Panama City: Astronomical Society of Bay County, P.O. Box 16356, 32405, Bob Gent, (904) 784-1603, Re-established 1991, 32 members.

Pensacola: Escambia Amateur Astronomers, 6235 Omie Circle, 32504-7625, Dr. J. Wayne Wooten, (904) 477-8859. Founded 1977, 130 members. Biweekly sky interpretation programs at Ft. Pickens June-Aug.

St. Augustine: Ancient City Astronomy Club, P.O. Box 546, 32085-0546, A.L. Ponjee. Founded 1974, 25 members.

St. Petersburg: St. Petersburg Astronomy Club Inc., 594 59th St. South, 33707, Daniel W. Bricker, (813) 343-1594. Founded 1927, 140 members. Operates Hickory Hill Observing Complex.

Tallahassee: Tallahassee Astronomical Society, 611 Collins Dr., 32303, Joseph Haley, (904) 386-1874, Re-established 1991, 25 members. Access to observatory with 14" SCT.

Tampa: Museum Astronomy Resource Society (MARS), 2602 E. 98th Avenue, 33612, Craig MacDougal, (813) 933-9617. Founded 1984, 25 members.

GEORGIA

Athens: Athens Astronomical Association, 160 Plantation Dr., 30605, Maurice E. Snook, (404) 543-3753. Founded 1977, 20 members.

Atlanta: Astronomical Society of the Atlantic, Georgia State Univ., Center for High Angular Resolution Astronomy, 30303-3083, Don Barry, (404) 237-5055. Founded 1988, 220 members, observatory with 30" scope. Public viewing nights. Hosts annual Georgia Star Party.

Atlanta: Atlanta Astronomy Club, P.O. Box 29631, 30359, Hal Crawford, (404) 320-9156. Founded 1947, 175 members, observatory with 20" scope. Public viewing nights. Hosts annual Summer Star Festival.

Augusta: Astronomy Club of Augusta, P.O. Box 6373, 30907, John T. White, (404) 860-6115. Founded 1986, 48 members. Public star parties.

Macon: Middle Georgia Astronomical Society, Museum of Arts and Sciences, 4182 Forsyth Rd., 31210, Gary L. Kretsinger, (912) 956-2145.

Savannah: Oglethorpe Astronomical Association, c/o Savannah Science Museum, 4405 Paulsen St., 31405, Vickie Watson, (912) 355-6705. Founded 1969, 20 members.

HAWAII

Hilo: Mauna Kea Astronomical Society, 175 Banyan Dr., #217, 96720, Bruce Marten, (808) 969-7357. Founded 1980, 80 members. Monthly public viewing nights at Hale Pohaku (9000' level) on Mauna Kea.

Honolulu: Hawaiian Astronomical Society, P.O. Box 17671, 96817, Phyllis Eide. Founded 1949, 150 members, observatory with 12.5" scope. Monthly public viewing nights.

Pu'unene: Maui Astronomy Club, P.O. Box 1168, 96784, Daniel O'Connell, (808) 878-3172. Founded 1986, 12 members.

Waimea: Kaua'i Educational Association for Science and Astronomy, P.O. Box 161, 96796, Pete Bilbo, (808) 245-8250, observatory (18.5" scope). Monthly star parties at Barking Sands.

IDAHO

Boise: Boise Astronomical Society, P.O. Box 8386, 83707. Founded 1982, 72 members. Hosts Southern Idaho Regional Star Party.

Idaho Falls: Idaho Falls Astronomical Society, 1710 Claremont Lane, 83404, Jim Ruggiero, (208) 524-6317. Founded 1966, 18 members. Hosts annual Star Party Campout in July.

Pocatello: Pocatello Astronomical Society, 1543 Saratoga, 83201.

ILLINOIS

Batavia: Fox Valley Astronomical Society, P.O. Box 508, 60510, Thomas Peck, (708) 232-1526. Founded 1944, 45 members, observatory with 16" Newtonian. Public viewing nights.

Champaign: Champaign-Urbana Astronomical Society, c/o Champaign Park District, 706 Kenwood Rd., 61821, David Leake, (217) 398-2550, Monthly public viewing nights.

Chicago: Chicago Astronomical Society, P.O. Box 48504, 60648, Michael Barrett, (312) 725-5618. Founded 1862, 150 members.

Glenview: Skokie Valley Astronomers, 910 Glenwood Lane, 60025, Gretchen George, (312) 998-1627. Founded 1984, 19 members.

Jacksonville: Central Illinois Astronomical Association, Illinois College, 62650, Frederick Pilcher, (217) 245-3412. Founded 1986, 10 members, observatory with 14" SCT. Public viewing nights.

Libertyville: Lake County Astronomical Society, 603 Dawes St., 60048, Jack Kramer, (708) 362-0959. Founded 1982, 50 members. Public viewing nights at Lake County Museum.

Lisle: Illinois Benedictine College Astronomical Society, 5700 College Road, 60532-2099, Robert S. Buday, (312) 969-6550. Founded 1965, 15 members, observatory with 16.5" Springfield scope.

Montgomery: Amateur Astronomers of Aurora, 69 Sheffield, 60538.

Mount Olive: Mount Olive Astronomical Society, 412 West 4th St. South, 62069.

Naperville: Naperville Astronomical Association, 9 S. 774 Route 59, 60564, Drew Carhart, (708) 978-1133. Founded 1973, 75 members, observatory with 10" Newtonian. Weekly public nights at Glen D. Riley Observatory June-Aug.

Normal: Twin City Amateur Astronomers, P.O. Box 755, 61761-0755, Sharon MacDonald, (309) 827-4885. Founded 1960, 60 members. Hosts annual Astronomy Rendezvous and Conference.

Palos Hills: Astronomical Association of the Univ. of Illinois, 8850 W. 101st Place, 60465, Suresh K. Sreenivasan, (708) 599-2458, 34 members.

Peoria: Peoria Astronomical Society, 1125 West Lake

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Ave., 61614, Charles Lamb, (309) 686-7000. Founded 1953, 120 members. Northmoor Observatory (9" refractor) and Jubilee Observatory (24" reflector). Public viewing nights.

Quincy: Quincy Astronomical Society, 1200 St. Charles Dr., 62301-7160, Kevin Clymer, (217) 222-6535. Founded 1981, 20 members, observatory with 16" scope. Public viewing nights.

Rock Island: Popular Astronomy Club, John Deere Planetarium, Augustana College, 61201, Paul Castle, (309) 786-6119. Founded 1936, 63 members.

Rockford: Rockford Amateur Astronomers Inc., 6804 Alvina Rd., 61101, Barry or Carol Beaman, (815) 964-6457. Founded 1958, 55 members. Public viewing at Lockwood Park Observatory (10" refractor).

Schaumburg: Northwest Suburban Astronomers, 1417 Harvard Lane, 60193, Detlef Schmidt. Founded 1971, 120 members.

Springfield: Springfield Astronomy Society, 2224 S. 13th St., 62703, Don Walker.

St. Charles: Argonne Astronomy Club, 6N106 White Oak Ln., 60175, H. F. DaBoll, (312) 584-1162.

INDIANA

Evansville: Evansville Astronomical Society, P.O. Box 3474, 47733, Scott Conner, (812) 424-8639. Founded 1952, 55 members, observatory with 14" SCT. Public viewing nights.

Fort Wayne: Fort Wayne Astronomical Society, P.O. Box 6004, 46896, Neil Ainslie. Founded 1959, 100 members, observatory with 12.5" scope. Public viewing nights. Hosts Three Rivers Festival Public Star Parties July 11 & 18.

Griffith: Calumet Astronomical Society, P.O. Box 851, 46319, Stephen Miller, (219) 845-9174. Founded 1975, 50 members. Observatory with 16" Newtonian. Seasonal public star parties at Lemon Lake County Park.

Mooresville: Indiana Astronomical Society, 2 Wilson Dr., 46158, J. Philip May, (317) 831-8387. Founded 1933, 150 members, observatory with 36" scope.

South Bend: Michiana Astronomical Society, P.O. Box 262, 46624-0262, John Greenlee, (219) 255-8501. Founded 1974, 22 members. UPS stuff to: Tom Laskowski, 1334 E. Miner St. South Bend, IN 46617.

Warsaw: Warsaw Astronomical Society, R.R. 8, Box 236, 46580, Jim Tague, (219) 269-1856. Founded 1981, 25 members, observatory with 12.5" Newtonian. Public viewing every clear Saturday.

West Lafayette: Wabash Valley Astronomical Society, 2367 Yeager Rd. #102, 47906, William Annis, (317) 463-3741. Founded 1970, 35 members, observatory with 14" SCT. Open houses 1st & 3rd Saturdays of the month.

IOWA

Ames: Ames Area Amateur Astronomers, 1208 Wilson Ave., 50010, David Oesper, (515) 232-8705. Founded 1979, 81 members. Monthly public star parties at McFarland Park Observatory (12.5" scope).

Burlington: Southeastern Iowa Astronomy Club, 601 Walnut St., 52601-5902, Jim Blair, (319) 753-2509. Founded 1984, 94 members, observatory with 12" refractor. Public nights first Fri. each month. Hosting Astronomy Days Oct. 17-18.

Cedar Rapids: Cedar Amateur Astronomers, 1513 Parkwood Lane NE, 52402, Frank Olsen, (319) 393-5758. Founded 1977, 30 members.

Davenport: Quad Cities Astronomical Society, P.O. Box 3706, 52806, Wayne Jens, (319) 326-4995. Founded 1980, 45 members, observatory with 20" scope. Public viewing nights. Hosts Eastern Iowa Star Party.

Des Moines: Des Moines Astronomical Society, Inc., c/o C. L. Allen, 2307 49th St., 50310-2538, C. L. Allen. Founded 1970, 35 members, observatory with 16" scope. Public viewing nights.

Iowa City: Iowa City Amateur Astronomers, 426 Dakota Trail, R.R. 7, 52240, Donald Johnson, (309) 338-4772. Founded 1990, 30 members.

KANSAS

Salina: Salina Astronomy Club, 803 Mike Dr., 67401, Keith Rawlings, (913) 827-6004. Founded 1988, 25 members, observatory with 16" scope. Public viewing nights.

Topeka: Northeast Kansas Amateur Astronomers League, P.O. Box 951, 66601, Roger Heaton. Founded 1978, 45 members.

Wichita: Kansas Astronomical Observers, c/o Wichita Children's Museum, 435 South Water, 67202, Vicki Johnston, (316) 267-2281. Founded 1977, 30 members.

Wichita: Wichita Astronomical Society, 2100 University Ave., Friends University, 67213.

KENTUCKY

Fort Wright: Midwestern Astronomers, 1643 Elder Court, 41011.

Golden Pond: West Kentucky Amateur Astronomers, Land Between the Lakes, 42211-9001, Jim Boren, (615) 232-6820. Founded 1980, 20 members, observatory with 17.5" reflector. Public viewing nights. Hosts Twin Lakes Star Party .

Lexington: Blue Grass Astronomical Society, 1016 Della Dr., 40504, Bradley Canon, (606) 278-6155. Founded 1959, 25 members.

Louisville: Louisville Astronomical Society, P.O. Box 20742, 40250-0742, Chuck Allen, (502) 267-4074. Founded 1933, 65 members, observatory in planning stages. Monthly observing sessions.

LOUISIANA

Baton Rouge: Baton Rouge Astronomical Society, Inc., 17324 Gains Mill Ave., 70817, (504) 344-9465. Founded 1981, 40 members. Starline: 344-0535.

New Orleans: Pontchartrain Astronomy Society, 820 Emerald St., 70124, Barry Simon, (504) 283-7592. Founded 1959, 135 members, observatory with 14" scope. Public viewing nights. Hosts Deep South Regional Stargaze.

Shreveport: Shreveport Astronomy Soc., 353 Ockley Dr., 71105, Jennie Goodwin, (318) 865-2433. Founded 1959, 40 members, observatory with 16" telescope. Public star parties May 9, Aug. 8, & Nov. 7.

MAINE

Bangor: Penobscot Valley Star Gazers, R.R. 1, Box 2319, 04401, Jeff Churchill, (207) 947-3643. Founded 1990, 26 members.

Eliot: Astronomical Society of Northern New England, 80 Goodwin Rd., 03903, Ray Sutton, (207) 439-4474, 50 members.

Fairfield: Central Maine Astronomers, 4 Osburne St., 04937, John and Alison Meader, 14 members.

MARYLAND

Arnold: Anne Arundel Association of Amateur Astronomers, Anne Arundel Community College, 101 College Parkway, 21012.

Baltimore: Baltimore Astronomical Society, 601 Light St., 21230, (301) 685-2370. Founded 1881, 140 members, observatory with 8" Clark refractor. Public viewing nights.

Bel Air: Harford County Astronomical Society, P.O. Box 906, 21014, Richard Hagenston, (410) 939-4772. Founded 1970, 60 members, observatory with 16" scope. Monthly public viewing nights.

Cumberland: Cumberland Astronomy Club, 350 Bedford St., 21502, G. Frank Simpson, (301) 722-7606. Founded 1964, 30 members. Owns 12.5" scope. Public viewing nights.

Greenbelt: Goddard Astronomy Club, Goddard Space Flight Center, Code 440.8, 20771, George Gliba, (301) 345-4760. Founded 1961, 50 members, observatory with 20" scope.

Greenbelt: National Capital Astronomers, 7006 Megan Lane, 20770, David and Joan Dunham, 258 members.

Hagerstown: Tri-State Astronomers, Washington County Planetarium, 823 Commonwealth Ave., 21740, James Taylor, (304) 274-1886. Founded 1985, 40 members, observatory with 16" scope.

Westminster: Westminster Astronomical Society, 3481 Salem Bottom Rd., 21157, Curtis Roelle, (301) 848-6384. Founded 1984, 70 members.

MASSACHUSETTS

Amherst: Amherst Area Amateur Astronomers Association, 1403 South East Street, 01002, Tom Whitney, (413) 256-6234. Founded 1984, 60 members, observatory with 18" Clark refractor. Public viewing every clear Saturday night.

Boston: Amateur Telescope Makers of Boston, 28 Taschereau Blvd., Nashua, NH 03062, Marion Hochuli. Founded 1934, 290 members. Recorded information: (508) 692-8708.

Groveland: North Shore Amateur Astronomy Club, 15 Cannon Hill, 01834, Robert Nelson, (508) 373-0236. Founded 1989, 45 members. Public viewing nights.

Harwich: Cape Cod Astronomical Society, P.O. Box 56, 02645, Jim Carlson, (508) 432-4316. Founded 1985, 52 members. Free monthly public programs. Star parties every clear Wednesday evening.

Norwell: South Shore Astronomical Society, P.O. Box 429, Jacobs Lane, 02061, Rolf Egon, (617) 337-2572. Founded 1958, 55 members, observatory with 10" Cassegrain. Public viewing nights.

Plymouth: Bay Colony Astronomical Society, 7 Morton Park Rd., 02360-3554. Founded 1990, 14 members. Owns 10" scope.

Sterling: Aldrich Astronomical Society, 57 Swett Hill Rd., Howard Beshia, (508) 422-8869. Founded 1932, 42 members, observatory with 12.5" scope.

West Springfield: Springfield Stars Club, 107 Lower Beverly Hills, 01089, John E. Welch, (413) 734-9179. Founded 1948, 75 members, observatory with 20" SCT. Public viewing.

White Horse Beach: Plymouth Star Searchers Astronomy Club, P.O. Box 255, 02381-0255, Roy Zahreciyan, (508) 224-6366. Founded 1990, 25 members. Monthly theme star parties.

MICHIGAN

Adrian: Astronomical Society of Lenawee County, Box 229, Hudson, 49247, Wes Boyd, (517) 547-7402. Founded 1990, 12 members, observatory with 6" scope open to the public. Hosts Public Stargaze July 9, 10, & 11.

Alpena: Huron Amateur Astronomers, P.O. Box 53, 49707. Founded 1989, 18 members.

Brighton: Friends United Through Astronomy, 8191 Woodland Shore, Lot #12, 48116, Gary Anderson, (313) 227-9347. Founded 1982.

East Lansing: Capital Area Astronomy Club, Abrams Planetarium, Michigan State Univ., 48824, David Batch, (517) 355-4676. 60 members.

Flint: Genesee Astronomical Society, c/o Robert Longway Planetarium, 1310 E. Kearsley St., 48503, Richard Walker, (313) 627-9524. Founded 1950, 20 members.

Hillsdale: Astronomical Society of Hillsdale County, 500 North Dunes Rd., 49242, Pat Calligan, (517) 439-1295. Founded 1985, 30 members. 25" scope available at Kimball Camp.

Holland: Shoreline Amateur Astronomical Association, 4679 46th St., 49423, Mark Logsdon, (616) 772-4904. Founded 1989, 15 members.

Kalamazoo: Kalamazoo Astronomical Society, Kalamazoo Public Museum, 315 South Rose St., 49007, Eric Schreur, (616) 345-7092. Founded 1936, 20 members, observatory with 12.5" scope. Public viewing nights.

Lowell: Grand Rapids Amateur Astronomical Association, 3308 Kissing Rock Rd. SE, 49331, Evelyn Marron, (616) 897-7065. Observatory with 17" Newtonian and 6" refractor open 2nd Saturday and last Friday of each month.

Marquette: Marquette Astronomical Society, P.O. Box 761, 49855, Brian Halbrook, (906) 228-6351. Founded 1974, 25 members, observatory with 8" scope. Public viewing nights.

Midland: Sunset Astronomical Society, 4300 Washington, 48640, Bill Albe, (517) 835-4142. Founded 1974, 30 members, observatory with 16" SCT. Public viewing nights.

Muskegon: Muskegon Astronomical Society, P.O. Box 363, 49443, Dale Johnson, (616) 798-7680. Founded 1970, 35 members, observatory with 12.5" reflector. Public viewing nights.

Petersburg: Toledo Astronomical Association, 8534 Covert Rd., 49270, Courtney Earhart, (313) 856-6204. Founded 1975, 45 members, observatory with 26"scope. Public viewing nights. Hosting Astronomy Day May 23.

Plymouth: Astronomical Society of Michigan, 11422 Waverly, 48170, Michael Best, (313) 459-2378. Founded 1985, 220 members.

Traverse City: Grand Traverse Astronomical Society, 5999 Secor, 49684, Jerry Dobek, (616) 922-1260. Founded 1982, 32 members, observatory with 14" SCT.

Warren: Warren Astronomical Society, P.O. Box 1505, 48090-1505, Alan Rothenberg. Founded 1961, 125 members, observatory with 12.5" scope.

Westland: Detroit Astronomical Soc., 7450 N. Kingston Ct., 48219, Jack Brisbin, (313) 455-7827. Founded 1931, 60 members. Skywatchers Hotline (313) 837-0130.

Ypsilanti: EMU Astronomy Club, 303 Strong Hall, Eastern Michigan Univ., 48197, Norbert Vance, (313) 487-3033. Founded 1977, 20 members, observatory (12.5" & 10" scopes). Public viewing nights.

MINNESOTA

Afton: 3-M Astronomical Society, 14601 55th St. South, 55001.

Brainerd: North Star Astronomy Club, 606 South 8th St., 56401-4118, David Starkka, (218) 829-4029. Founded 1982, 25 members.

Duluth: Arrowhead Astronomical Society, Alworth Planetarium, Univ. of Minnesota-Duluth, 55812, Glenn Langhorst, (218) 726-7129. Founded 1979, 30 members.

Moorhead: Fargo-Moorhead Astronomical Society, P.O. Box 28, Concordia College, 56560, Jeff Struck, (218) 739-3453. Founded 1970, 15 members. Monthly public star parties.

New Ulm: Minnesota Valley Amateur Astronomers, Route 4, Box 15A, 56073, Roger Dier, (507) 359-2488. Founded 1986, 20 members. Hosts annual Southern Minnesota Sky Show.

Northfield: Cannon Valley Astronomical Society, 1225–330th St. East, 55057, Steve Messner, (507) 645-8347. Founded 1991, 12 members.

St. Paul: Minnesota Astronomical Society, c/o Science Museum of Minnesota, 30 East 10th Street, 55101, Max Radloff, (612) 643-4092. Founded 1973, 170 members, observatory with 16" scope. For star party dates call (612) 451-7680.

MISSISSIPPI

French Camp: Rainwater Astronomical Association, French Camp Academy, 39745, James Hill, (601) 547-6865. Founded 1987, 45 members, observatory with 13 instruments including 30" reflector. Public viewing nights.

Jackson: Jackson Astronomical Association, 6207 Winthrop Circle, 39206-2323, Walter Rebmann, (601) 982-2317. Founded 1975, 43 members, observatory with 13" scope.

MISSOURI

Blue Springs: Astronomical Society of Kansas City, P.O. Box 400, 64013, Gary Pittman, (816) 228-4238. Founded 1936, 180 members, observatory with 30" scope. Public viewing nights.

Columbia: Central Missouri Amateur Astronomers, 261 Stardust Lane, 65201.

Dawn: North Central Missouri Amateur Astronomers, Route 1 Box 111, 64638, Jim Jones, 10 members.

Florissant: McDonnell Douglas Amateur Astronomy Club, 3491 Heather Trail Dr., 63031, Richard Melvin, (314) 569-4773.

Fort Leonard Wood: Ozarks Telescope Makers & Amateur Astronomers, 29 Williams Street, 65473, Peter Bessenbruch, (314) 329-3344. Founded 1987, 45 members. Hosts annual Ozarks Star Party.

Hannibal: Mark Twain Astronomical Society, 45 Pioneer Trail, 63401, William J. Remillong.

Hazelwood: Rural Astronomers of Missouri, 209C Chapel Ridge, 63042, Greg Rigelman, (314) 895-3864. Founded 1976, 22 members.

Riverside: Prairie View Astronomical Society, 931 NW Valley Lane, 64150.

St. Louis: St. Louis Astronomical Society, 11610 Sheffield Drive, 63033, Amy White, (314) 741-9904. Founded 1936, 287 members. Monthly public star parties.

MONTANA

Missoula: Western Montana Astronomical Association, 9285 Miller Creek Rd., 59803, Bill Elison, (406) 251-4825, 20 members.

NEBRASKA

Lincoln: Prairie Astronomy Club, P.O. Box 80553, 68501, Ron Veys, (402) 486-1449. Founded 1960, 63 members, observatory with 14" SCT. Hosts annual Star Party Aug. 8.

Omaha: Omaha Astronomical Society, 5025 S 163 St., 68135, Bill Jacobsen, 89 members.

NEVADA

Elko: Elko Astronomical Society, 550 South 12th #22, 89801, Len Seymour, (702) 738-7916. Founded 1987, 20 members.

Las Vegas: Las Vegas Astronomical Society, Clark County Community College, 3200 East Cheyenne Avenue, 89030, Jim Mellor, (702) 361-1356. Founded 1980, 125 members. Hosts annual Dark Sky Observing Party.

Reno: Astronomical Society of Nevada, 3445 Becard Lane, 89506-8803, Jaavier Acordagoitia, (702) 677-8287. Founded 1934, 70 members, observatory with 12.5" and 24" scopes.

NEW HAMPSHIRE

Claremont: Springfield Telescope Makers, Chapel Grove, Box 434, 03734, Norman Fredrick, (603) 542-2928.

Keene: Keene Amateur Astronomers Inc., 131 Carroll St., 03431, Paul Fisher, (603) 352-6393. Founded 1950, 35 members, observatory with 13.1" scope.

Penacook: New Hampshire Astronomical Society, 22 Center St., 03303, Nelson D. LaClair, (603) 753-9225. Founded 1979, 30 members.

NEW JERSEY

Boonton: Sheep Hill Astronomical Association, P.O. Box 111, 07005, Evert Bono, (201) 335-5990. Founded 1972, 46 members, observatory with 16" Newtonian. Monthly public viewing nights.

Clifton: North Jersey Astronomical Group, P.O. Box 4021, Allwood Station, 07012, John Miksits, (201) 365-2577. Founded 1981, 67 members, observatory with 14" SCT. Biweekly public nights. Call (201) 345-STAR.

Cranford: Amateur Astronomers Inc., Sperry Observatory, 1033 Springfield Ave., 07016, George Chaplenko, (908)549-0615. Founded 1949, 380 members, observatory with 24" scope. Public viewing nights.

East Hanover: Morris Museum Astronomical Society, 6 Deforest Ave., 07936, Ronald Russo, (201) 386-1848. Founded 1962, 51 members.

Glassboro: Tychonian Observers, Glassboro State College, Dept. of Physical Sciences, 08028, W. C. Woods, Jr., (609) 863-6336. Founded 1962, 25 members, observatory with 6" scope.

Glen Rock: Montclair Telescope Club Inc., 14 Iona Place, 07452, C. Thomas Massey, (201) 447-2581. Founded 1955, 30 members.

High Bridge: New Jersey Astronomical Association, P.O. Box 214, 08829, Ben Cavotta, (201) 638-8500. Founded 1965, 178 members, observatory with 26" scope.

Holmdel: STAR Astronomy Society, P.O. Box 547, 07733, Gary Romans, (908) 536-4663. Founded 1957, 50 members.

Jamesburg: Concordia Astronomy Club, P.O. Box 22, 08831-0022, Donald Landsman, (609) 395-7182. Founded 1988, 116 members.

Princeton: Amateur Astronomers Association of Princeton, P.O. Box 2017, 08540, Greg Mauro, (609) 586-5732. Founded 1973, 80 members, observatory with 12.5" Newtonian. Public viewing nights. Hosts Jersey StarQuest.

Toms River: Astronomical Society of the Toms River Area (ASTRA), Novins Planetarium, Ocean County College, 08754-2001, Erik Zimmerman, (201) 255-0343. Founded 1977, 60 members.

West Mulford: The Dark Sky Observers, c/o Ginger Payne, 15E Concord Road, 07480. Founded in 1991, 10 members.

Williamstown: Willingboro Astronomical Society, Rt. 8, Box 362-A, 08094, Jack Koch, (609) 629-0180. Founded 1957, 36 members, observatory with 14" reflector.

NEW MEXICO

Alamogordo: Alamogordo Amateur Astronomers, 1210 Filipino, 88310, Paula Hamilton, (505) 434-0115.

Albuquerque: Albuquerque Astronomical Society, P.O. Box 54072, 87153-4072, George Pellegrino, (505) 821-8516. Founded 1958, 200 members, observatory with 16" Newtonian. Public viewing nights.

Clovis: Clovis Astronomy Club, 216 Sandzen, 88101. Founded 1985, 12 members.

Hobbs: Lea County Astronomical Society, NMJC Science Building, 5317 Lovington Highway, 88240, Dr. V.G. Berner, (505) 392-4510. Founded 1977, 20 members.

Las Cruces: Astronomical Society of Las Cruces, P.O. Box 921, 88004, Larry Lindsey, (505) 526-4136. Founded 1951, 80 members, observatory with 12" scope. Public viewing nights.

NEW YORK

Bellmore: Astronomical Society of Long Island, 801 Oak St., 11710, Alan Buckley, (516) 221-5914. Founded 1965, 110 members. Monthly observing sessions.

Black River: Northern New York Astronomical Society, RD 1, Box 149, 13612, Bill Mack, (315) 773-5807.

Buffalo: Buffalo Astronomical Association Inc., Buffalo Museum of Science, Humboldt Parkway, 14211, Doris Koestler, (716) 683-2970. Founded 1937, 110 members.

Chappaqua: Westchester Amateur Astronomers, P.O. Box 111, 10514, Robert Davidson, (914) 238-4533. Founded 1983, 70 members, observatory with 24" scope. Monthly public viewing nights.

Clinton: Mohawk Valley Astronomical Society, Hamilton College, Box 674-B, 13323, Richard Somer, (315) 853-6056. Founded 1989, 153 members, observatory with 11" Maksutov. Monthly star parties.

Corning: Elmira-Corning Astronomical Society, 17 West Hazel St., 14830, Marilyn L. O'Connell, (607) 962-5435. Founded 1960, 60 members.

Frewsburg: Marshal Martz Memorial Astronomical Assoc., 176 Robin Hill Rd., 14738, Tom Bemus, (716) 386-4566. Founded 1979, 80 members, observatory with 30" Newtonian.

Getzville: Association of Observational Astronomers of Western New York, 1955 Hopkins Rd., 14068, Carl Milazzo, (716) 688-4869. Founded 1989, 65 members.

Hamburg: Southtowns Astronomy Club, 145 Woodward, West Seneca, 14224, Rhonda Garbowski, (716) 649-6759. Founded 1991, 17 members. Monthly star parties. Hosting Astronomy Day, date to be announced.

Jamesport: Custer Institute Astronomy Club, P.O. Box 645, 11947, Barbara Lebkuecher, (516) 765-2626. Founded 1929, 150 members, observatory with 6" Clark refractor. Hosts annual Astronomy Jamboree.

Kirkville: Assoc. of Solar, Planetary & Lunar Obs., P.O. Box 95, 13082, Raymond Coneley. Founded 1991, 10 members. Owns 10" Cassegrain.

Lake Placid: Tri-Lakes Astronomical Society, 100 Sentinel Rd., 12946, George R. Viscome, (518) 523-2052. Founded 1986, 20 members.

Lindenhurst: Amateur Observers' Society of New York, P.O. Box 838, 11757-0838, Eric Barnes, (516) 242-6925. Founded 1965, 51 members. Public star parties at Robert Moses State Park June 6 & 27.

Lockport: Lockport Astronomy Association, 7053 Northview Dr., 14094, Richard Lahrs, (716) 433-4706. Founded 1966, 25 members, Remick Memorial Observatory (12" scope). Public viewing every Wed. night May-Oct.

New York: Amateur Astronomers Association, 1010 Park Ave., 10028, John Marshall, (212) LE5-2922. Founded 1929, 600 members, observatory. Monthly public star parties in New York area.

Pearl River: Rockland Astronomy Club, 110 Pascack Ave., 10965, Allan Green, (914) 735-4163. Founded 1972, 275 members. Monthly star parties at Harriman State Park.

Rochester: Astronomy Section, Rochester Academy of Science, P.O. Box 20292, 14602, Mark Torrens, (716) 987-5330. Founded 1932, 120 members, observatory with 12" scope. Computer Bulletin Board: (716) 865-0811.

Rochester: RIT Astronomy Club, Rochester Institute of Technology, Dept. of Physics–08, 14623. Founded 1989, 30 members.

Schenectady: Albany Area Amateur Astronomers, 1529 Valencia Rd., 12309, Bob Mulford, (518) 374-8744. Founded 1949, 80 members, owns portable 18" Dobsonian. Public viewing nights.

Staten Island: Astronomical Society of New York City, 153 Arlo Rd., 10301, T. W. Hamilton, (718) 727-1967.

Staten Island: Wagner College Astronomy Club, 631 Howard Ave., 10301, Paul Albicocco, (317) 390-3341.

Syracuse: Syracuse Astronomical Society Inc., 1115 East Colvin St., 13210, Jos. Italiano, (315) 476-7713. Founded 1920, 125 members, observatory with 16" Newtonian. Public viewing nights. Hosts annual Summer Seminar.

Valley Stream: Valley Stream Astronomical Society, 14 Charles St., 11580-2217.

Vestal: Kopernik Astronomical Society, Kopernik Observatory, Underwood Rd., 13850, Jay Edwards, (607) 748-3685. Founded 1960, 150 members, observatory with 20" scope. Public viewing nights. July star parties.

NORTH CAROLINA

Albemarle: Stanly County Astronomical Society, P.O. Box 1269, 28001-1269, Herbert Hartley, (704) 982-3728. Founded 1985, 15 members. Monthly star parties at Morrow Mountain State Park June-Aug.

Asheville: Starfax Association, P.O. Box 6084, 28816, Timothy Jordan. Founded 1981, 40 members.

Castle Hayne: Cape Fear Astronomy Club, 110 Linville Dr., 28429, Paul Petty, (919) 675-2952. Founded 1984, 26 members. Meetings 1st Sun. each month.

Fayetteville: Astronomy Club of Cumberland County, 2308 Colgate Dr., 28304, Allen Faircloth, (919) 485-8515. Founded 1983, 20 members.

Gastonia: Gaston Astronomy Club, P.O. Box 953, 28054, Larry Benefield, (704) 825-5341.

Goldsboro: Eastern Carolina Astronomy Club, 1607 Munroe Lane, 27543, Robert Krieger, (919) 778-3377. Founded 1988, 53 members.

Granite Falls: Catawba Valley Astronomy Club, Route 3, Box 472, 28630, Greg Kirby, (704) 396-7656. Founded 1976, 50 members. Hosts annual Blue Ridge Parkway Regional Stargaze.

Greensboro: Greensboro Astronomy Club, 5339 Vickrey Chapel Rd., 4301 Lawndale Dr., 27407, Lorraine Moore, (919) 454-1820. Founded 1949, 44

members. Viewing nights 4th Fri. each month.

Matthews: Charlotte Amateur Astronomers Club, 245 Timber Lane, 28105, Gayle Riggsbee, (704) 846-3136. Founded 1954, 80 members, observatory with 17.5" scope. Public viewing nights.

Raleigh: Raleigh Astronomy Club, P.O. Box 10643, 27605, Mark Lang, (919) 460-7900. Founded 1978, 65 members, observatory with 24" scope.

Salisbury: Astronomical Society of Rowan County, Margaret Woodson Planetarium, 1636 Parkview Circle, 28144, Ellen Trexler, (704) 636-3462.

Thomasville: Thomasville Area Astronomy Club, 918 Alice Dr., 27360, Delbert Houston, (919) 431-5062. Founded 1986, 30 members.

Statesville: Piedmont Amateur Astronomers, Route 2, P.O. Box 181, Troutman, 28166, Ronnie Sherril, (704) 528-9316. Founded 1988, 22 members.

Winston-Salem: Forsyth Astronomical Society, 820 Duckview Court, 27106-3603. Founded 1937, 35 members.

NORTH DAKOTA

Bismarck: Dakota Astronomical Society, P.O. Box 2539, 58502-2539, John Wetsch, (701) 256-3620. Founded 1987, 50 members. Hosts annual Dakota Star Watch.

OHIO

Akron: Astronomy Club of Akron, 2853 Lynne Rd., 44312, James W. Anderson, (216) 644-9314. Founded 1949, 120 members, observatory with 12.5" scope. Public viewing nights.

Chagrin Falls: Chagrin Valley Astronomical Society, P.O. Box 11, 44022, Bob Modic, (216) 731-0522. Founded 1963, 20 members. Observatory with 16" telescope. Public viewing nights.

Cincinnati: Cincinnati Astronomical Society, 5497 Washigo Dr., 45230. 154 members.

Cleveland: Cleveland Astronomical Society, Warner and Swasey Observatory, Case Western Reserve Univ., 44106, William Shore, (216) 461-1918.

Cleveland: Cuyahoga Astronomical Association, P.O. Box 29089, 44129-0089, William Gerling, (216) 779-9779. Founded 1959, 80 members. Hosting Ohio Turnpike Astronomers Association Convention June 27.

Cleveland: Lewis Astronomy Club, 21000 Brookpark Rd., M.S. 16-1, 44135-3191, Martin Mayer, (216) 433-8451. Founded 1980, 10 members.

Columbus: Columbus Astronomical Society, 5280 Cape Cod Lane, 43235, Tom Burns, (614) 459-7742. Founded 1948, 200 members.

Dayton: Miami Valley Astronomical Society, 2629 Ridge Ave., 45414, Wade E. Allen, (513) 275-7431, 66 members.

Lima: Lima Astronomy Club, P.O. Box 201, 45801, Sam Little, (419) 422-8313, Operates Schoonver Observatory. Public viewing nights.

Lorain: Black River Astronomical Society, 1631 Maple Dr., 44052, Michael Harkey, (216) 288-8556. Founded 1948, 50 members. Owns 13.1" Dobsonian.

Mansfield: Richland Astronomical Society, P.O. Box 1118, 44901-9998, Keith Moore, (419) 468-3542. Founded 1960, 38 members, observatory with 31" Newtonian. Hosts annual Hidden Hollow Camp.

New Philadelphia: Tuscarawas County Amateur Astronomical Society, 1315 E. High Ave., 44663, Sam Krempasky, (216) 339-7335. Founded 1979, 10 members. Public star parties with a 13.1" Dobsonian.

Newton Falls: Mahoning Valley Astronomical Society, 1074 State, Rt. 534 NW, 44444. Founded 1938, 30 members, observatory with 16" Cassegrain. Public viewing nights. Hosts Ohio Turnpike Amateur Astronomers convention in Aug.

Ravenna: Kent Quadrangle Astronomical Society, 7353 State Route 14, Lot 12, 44266.

Rossford: Northwest Ohio Visual Astronomers, 1018 E. Elmtree Rd., 43460, Frank Myers, (419) 666-8566. Founded 1990, 10 members.

South Point: Ohio Valley Astronomical Society, Route 6, Box 350, 45680, Scott Hogsten, 13 members.

Tiffin: Sandusky Valley Amateur Astronomy Club, 650 S. Washington Street, 44883, Thomas Fretz, (419) 448-9377. Founded 1987, 35 members, observatory with 17.5" scope. Public viewing nights.

Troy: Stillwater Stargazers, Brukner Nature Center, 5995 Horseshoe Bend Rd., 45373, Ron Netzley, (513) 335-7225. Founded 1985, 20 members. Monthly star parties.

Wilmot: Wilderness Center Astronomy Club, P.O. Box 202, 44689-0202, Dave Gill, (216) 833-9399. Founded 1983, 60 members. Observes with a 16" Cassegrain.

OKLAHOMA

Ardmore: Arbuckle Astronomical Society, 713 Ash N.W., 73401, Steve Girard, (405) 226-0339. Founded 1984, 25 members. Public viewing night July 28, 1992.

Bartlesville: Bartlesville Astronomical Society, Route 2, Box 940, 74006, Ken Willcox, (918) 333-1966. Founded 1958, 24 members. Hosts annual Prairie Star Party.

Boise City: Cimarron County Star Gazers, P.O. Box 278, 73933, Jim Rosebery, (405) 544-2222.

Enid: Northwest Oklahoma Astronomy Club, 1719 Pawnee, 73703, Dan Mathews, (405) 233-5707. Founded 1978, 55 members. Hosts annual NW Oklahoma Star Party.

Oklahoma City: Oklahoma City Astronomy Club, P.O. Box 21221, 73156, Clive or Beryl Cadle, (405) 789-3742. Founded 1958, 85 members. Hosts annual Okie-Tex Star Party.

Purcell: Central Oklahoma Astronomy Club, P.O. Box 628, 73080.

Tulsa: Astronomy Club of Tulsa, 3832 S. Victor Ave., 74105, Newell Pottorf, (918) 742-7577. Founded 1937, 105 members, observatory with 16" scope. Public viewing nights.

OREGON

Bend: Central Oregon Astronomical Society, 17081 Cooper Dr., 97707.

Eugene: Eugene Astronomical Society, Lane ESD Planetarium, 2300 Centennial Blvd., 97402, Cuyla Shelton, (503) 345-7748. Founded 1959, 80 members.

Portland: Rose City Astronomers, Oregon Museum of Science and Industry, 4015 S.W. Canyon Road, 97221, Dale Fenske, (503) 255-2016. Founded 1890, 205 members. Hosts annual Oregon Star Party.

Roseburg: Umpqua Amateur Astronomers, Umpqua Community College, 3150 West Military Ave., 97470, Paul Morgan, (503) 673-1081. Founded 1987, 20 members.

Veronia: Northwest Astronomy Group, 55371 McDonald Rd., 97064, Sandy Mikalow, (503) 429-2430. Founded 1980, 50 members, observatory with 14" scope. Operates a HAM radio net for amateur astronomy.

PENNSYLVANIA

Allentown: Lehigh Valley Amateur Astronomical Society, 620 East Rock Rd., 18103, Paul Hunsburger, (908)669-3371. Founded 1957, 200 members, observatory with 20" scope.

Beaver: Beaver Valley Astronomy Club, 1335 3rd St., #2, 15009, David Yoder, (412) 728-5255. Founded 1975, 20 members.

Clarks Summit: Lackawanna Astronomical Society, 1112 Fairview Rd., 18411, John D. Sabia, (717) 586-0789. Founded 1959, 100 members, observatory with 17" scope. Public viewing nights.

Duncannon: Astronomical Society of Harrisburg, RD 4, Box 4038 Motter Rd., 17020, Calvin Cassel, (717) 834-9398. Founded 1955, 160 members, observatory with 17.5" telescope.

Erie: M-31 Astronomical Society, 86 Applewood Lane, 16509.

Glenshaw: Amateur Astronomers Association of Pittsburgh, P.O. Box 314, 15116, John Holtz, (412) 224-2510. Founded 1929, 250 members, observatory with 12.5" Newtonian. Monthly public star parties at Wagman Observatory. '

Haverford: Rittenhouse Astronomical Society, 216 Elbow Lane, 19041-1806, Nancy Blossom, (215) 642-4337. Founded 1888, 80 members.

Hazleton: Greater Hazleton Area Astronomical Society, P.O. Pox 151, 18201, Scott McAndrews, (717) 454-9640. Founded 1977, 50 members. Monthly public star parties.

Kane: Sir Isaac Newton Astronomical Society, 434 Greeves St., 16735, William Kearney, 15 members.

Lansdale: L5 Society of Philadelphia, 1825 Flintlock Circle, 19446, Jay B. Haines, (215) 855-7130.

Lewisburg: Bucknell Univ. Astronomy Club, Dept. Of Physics, Bucknell University, 17837, David Lien, (717) 524-3767. Founded 1990, 20 members. Access to 10" Clark refractor. Public viewing nights.

New Kensington: Kiski Astronomers, 69 Aluminum City Terrace, 15068, Dennis Sopchack, (412) 337-0509. Founded 1968, 35 members.

Philadelphia: Delaware Valley Amateur Astronomers, P.O. Box 662, Kimberton, 19442-0662, Marilyn Michalski, (215) 933-0497. Founded 1976, 180 members. Regular public star parties.

Reading: Berks County Amateur Astronomical Society, Reading School District Planetarium, 1211 Parkside Dr. South, 19611, Linda Sensenig, (215) 375-9062. Founded 1973, 40 members.

Warminster: Bucks-Mont Astronomical Association, 1443 Devon Rd., 18974, Edward Melnick, (215) 443-7929. Founded 1984, 50 members. Hosts annual Stella-Della-Valley star party.

Warren: Warren City Amateur Astronomers Club, 118 Falconer St., 16365, Tom Traub, (814) 723-9428. Founded 1972, 8 members.

York: York County Parks Astronomical Society, 400 Mundis Race Rd., 17402, Jeri Jones, (717) 225-3744. Founded 1988, 50 members. Hosts annual Mason-Dixon Star Party.

PUERTO RICO

Rio Piedras: Sociedad de Astron. de Puerto Rico Inc., Tegucigalpa 1025, Urb. Las Americas, 00921, Luis Maura, (809) 765-0889. Founded 1985, 70 members.

RHODE ISLAND

Newport: Celestial Observers of Rhode Island, 10 Redcross Terrace, 02840, John Hopf, (401) 521-5680, 45 members.

North Scituate: Skyscrapers Inc., 47 Peep Toad Rd., 02857, Conrad Cardano, (401) 828-0702. Founded 1932, 125 members, observatory with 8" Clark refractor and 20" reflector. Public viewing nights. Hosts Astro-Assembly in Oct.

SOUTH CAROLINA

Aiken: Aiken Astronomy Club, USC-Aiken, Buliding 106, 171 Univ. Parkway, 29801, Richard M. Albert, (803) 663-3105.

Central: Clemson Area Amateur Astronomers, 1550 Old Seneca Rd., 29630-9597, Dixon Lomax, (803) 654-3689. Founded 1982, 50 members, observatory with 12.5" Newtonian.

Greenville: Roper Mountain Astronomers, 504 Roper Mountain Rd., 29615, Doug Gegen, (803) 288-8595, Assists in operation of Daniel Observatory (23" Clark refractor).

Hanahan: Lowcountry Stargazers, 1313 Springhill Rd., 29406, John Smith, (803) 797-0146. Founded 1983, 50 members, observatory with 16" scope.

Irmo: Midlands Astronomy Club, 112 St. Albans Rd., 29063, Jim Heilman, (803) 781-0102. Founded 1970, 46 members. Hosting Astronomy Day June 20.

Ladson: Low Country Stargazers, 4424 Clovewood St., 29456, Danny Joe Williams, (803) 875-4260. Founded 1983, 28 members, observatory with 16" scope.

Rock Hill: Carolina Stargazers Astronomy Club, Museum of York County, 4621 Mt. Gallant Rd., 29730, M. Leon Knott, (803) 329-2121. Founded 1986, 95 members. Operates "Have Telescope, Will Travel" program.

SOUTH DAKOTA

Rapid City: Black Hills Astronomical Society, 4912 Breckenridge Court, 57702, Michael O'Connor, (605) 342-3793. Founded 1956, 20 members, observatory with 12.5" Newtonian.

Sioux Falls: Sioux Valley Astronomers, 500 S. Williams, 57104, Mel Pine, (605) 334-3398. Founded 1985, 25 members.

TENNESSEE

Brentwood: Barnard-Seyfert Astronomical Society, Dyer Observatory, 1000 Oman Dr., 32027, A. Heiser, (615) 373-4897. Founded 1927, 77 members. Public viewing nights.

Chattanooga: Barnard Astronomical Society, 838 Belvoir Hills Drive, P.O. Box 91296, 37412, F. Randolph Helms, (615) 629-6094. Founded 1923, 38 members, observatory with 20.5" scope. Monthly programs at UTC Observatory.

Kingsport: Bays Mountain Amateur Astronomers, 853 Bays Mountain Park Rd., 37660, (615) 229-9447. Founded 1980, 60 members, observatory with 17.5" reflector and 8" refractor. Hosts annual Starfest.

Knoxville: Orion Research Forum and Network, P.O. Box 50291, 37950, Bob Miles, (615) 588-3087. Founded

1977, 12 members.

Knoxville: Smoky Mountain Astronomical Society, P.O. Box 53265, 37950, Paul Lewis, (615) 974-7815. Founded 1977, 35 members, owns portable 20" Dobsonian. Public viewing nights 1st and 3rd Fridays at University Physics Building.

Manchester: Middle Tennessee Astronomical Society, 1305 Sycamore St., 37355-2067, Donald W. Male. Founded 1962, 10 members.

Memphis: Memphis Astronomical Society, 1229 Pallwood Rd., 38122, Richard Moore, (901) 682-2003. Founded 1956, 55 members, observatory with 20" scope.

Memphis: Society of Low Energy Observers, 4277 Park Forest Dr., 38141-7126. Founded 1989, 20 low-energy members.

TEXAS

Abilene: Abilene Astronomical Society Inc., 1109 Highland Ave., 79605, George Schroeder, (915) 677-5713.

Amarillo: Amarillo Astronomy Club, 4324 Summit Circle, 79109, Danny Zumbrun.

Austin: Austin Astronomical Society, P.O. Box 12831, 78711, Larry Kemp. Founded 1970, 90 members, observatory with 12.5" reflector. Public viewing nights.

Baycliff: Johnson Space Center Astronomical Society, 4802 Redfish Reef, 77518.

Beaumont: Astronomical Society of Southeast Texas, P.O. Box 7943, 77726-7943, Jim Heintzleman. Founded 1990, 45 members.

College Station: Association of Amateur Astronomers, Texas A&M Univ., Dept. of Physics, 77843-4242, Roger Smith, (409) 845-4179.

Corpus Christi: Corpus Christi Astronomical Society, 3814 Marion St., 78415, Gary Mayer, (512) 852-7643. Founded 1965, 10 members.

Dallas: Texas Astronomical Society, P.O. Box 25162, 75225, Evelyn Deen, (214) 517-6980. Founded 1946, 325 members.

Ft. Worth: Fort Worth Astronomical Society, P.O. Box 161715, 76161-1715, Jay Hornsby, (817) 451-8948. Founded 1949, 90 members, observatory with 12.5" scope. Public viewing nights.

Ft. Worth: General Dynamics Astronomy Club, 3400 Bryant-Irvin Rd., 76109, Ronald W. Evans, (817) 763-6244.

Ft. Worth: Texas Observers, 1501 Montgomery St., 76107, Don Garland, (817) 732-1631. Founded 1986, 10 members. Public viewing nights.

Georgetown: Williamson County Astronomy Club, 901 S. Church St., 78626, John Upton, (512) 838-1312, 35 members.

Houston: Houston Astronomical Society, P.O. Box 20332, 77225-0332, Scott Mitchell, (713) 461-3020. Founded 1955, 380 members, observatory with 14" scope. Hosts Houston Astronomy Day in Oct.

Houston: Students for the Exploration and Development of Space (SEDS), 918 Woolworth, 77020, Aiqin Huang, (713) 675-0047. Founded 1991, 50 members.

Houston: University Space Society, Univ. of Houston, Box 310 CA, UC, 77204-3650, Alvin Carley, (713) 921-7532. Founded in 1978, 20 members, observatory with 36" and various size scopes available.

Lake Jackson: Brazosport Astronomical Society, 400 College Dr., 77566, Steve Lamb, (409) 297-3984. Founded 1985, 10 members.

Lubbock: South Plains Astronomy Club, 1920 46th St., 79412-2214, Wayne Lewis, (806) 763-6800. Founded 1960, 30 members.

McAllen: Valley Astronomical Society, 7005 North 31st St., 78504.

Odessa: Odessa Observers, P.O. Box 301, 79760, F.A. McElvaney. Founded 1986, 6 members.

Odessa: West Texas Astronomers, P.O. Box 2855, 79760, Thomas Dutko, (915) 385-1158. Founded 1972, 32 members.

San Angelo: San Angelo Amateur Astronomy Assoc., P.O. Box 60391, 76906, Joseph Lynch, (915) 944-2113. Founded 1964, 32 members.

San Antonio: San Antonio Astronomical Association, 6427 Thoreau's Way, 78239, Rick Garcia, (512) 654-9784, 73 members.

Sanger: Denton County Astronomical Society, 225 Green Springs Circle, 76266, John Love, (817) 458-7479.

Stafford: Fort Bend Astronomy Club, P.O. Box 942, 77477-0942, Dennis Zwicky, (713) 499-4993. Founded 1984, 70 members. Assists with operation of 36" scope at George Observatory.

Texas City: College of the Mainland Astronomy Club, 1200 Auburn Rd., 77591-2449, John L. Hubisz, (409) 938-4098. Founded 1971, 30 members.

Tyler: Astronomical Society of East Texas, Hudnall Planetarium, P.O. Box 9020, 75711, Mike Mikule, (214) 561-3710. Founded 1987, 30 members. Monthly public star parties.

Victoria: Crossroads Astronomy Club, 233 Spur Dr., 77904, Derek Newton, (512) 578-5452. Founded 1990, 12 members.

Waco: Ursa Major Astronomy Society, Baylor Univ., Box 7316, 76798.

UTAH

Cedar City: Southern Utah Astronomy Group, 147 South 300 East, 84720, Brent Sorensen, (801) 586-2759. Founded 1986, 8 members, observatory with 14" SCT. Public viewing nights.

Roy: Ogden Astronomical Society, 2336 West 5650 South, 84067, Bob Tillotson, (801) 773-8106. Founded 1970, 35 members. Hosts annual Mountain States Star Party.

Salt Lake City: Salt Lake City Astronomical Society, Hansen Planetarium, 15 South State St., 84111-1590, (801) 538-2104. Founded 1965, 125 members, observatory with 16" scope. Public viewing nights.

VERMONT

Williston: Vermont Astronomical Society, P.O. Box 782, 05495, Frank Pakulski, (802) 985-3269. Founded 1964, 55 members, observatory with 10" scope. Public viewing nights.

VIRGINIA

Bassett: Piedmont Astronomy Club, P.O. Box 865, 24055, James I. Marshall.

Blacksburg: Astronomy Club of Virginia Tech, Virgina Polytechnic Institute, 216 Robeson Hall, 24061, John Abbott, (703) 953-0189. Founded 1970, 60 members, observatory with 14" SCT. Public viewing nights.

Bristol: Bristol Astronomy Club, 940 Reedy Creek Rd., 24201, Ken Childress, (703) 466-8404. Founded 1955, 24 members, observatory with 12.5" reflector. Public viewing nights.

Chesapeake: Back Bay Amateur Astronomers, 2808 Flag Rd., 23323-2102, Glendon L. Howell, (804) 485-4242. Founded 1978, 17 members. Monthly public star parties at Northwest River Park.

Fairfax: Northern Virginia Astronomy Club, 4415 Eastwood Court, 22032, Robert L'Hommedieu, (703) 978-0946. Founded 1980, 165 members. Hosts annual Northern Virginia Telescope Meet.

Fairfax: Nova Space Society, 4344 Mt. Carriage Lane, 22033, Jim Myska, (703) 803-7961.

Fredericksburg: Triangulum Astronomical Society, P.O. Box 7464, 22404, Mike Gill, (703) 371-2415. Founded 1983, 16 members. Public viewing nights.

Hampton: Skywatchers, 109 Mill Point Dr., 23669-3534, Marilyn E. Ogburn, (804) 864-1175. Founded 1950, 20 members, observatory with 16" scope. Public viewing nights.

Harrisonburg: Shenandoah Valley Astronomy Club, James Madison Univ., Dept. of Physics, 22801, Henry W. Leap, (703) 568-6109.

Lynchburg: Lynchburg Astronomy Club, 4648 Locksview Rd., 24503, Allen Majewski, (804) 384-5616.

Middletown: Shenandoah Astronomical Society, Lord Fairfax Community College, P.O. Box 47, 22645, Bill Warren, (703) 869-1120. Founded 1985, 30 members.

Nathalie: Halifax Skywatchers, P.O. Box 22, 24577-0022, Joe Lightcap, (804) 349-3700. Founded 1986, 15 members, observatory with 13" reflector.

Portsmouth: Astronomical Society of Tidewater, 2216 Country St., 23704, Leonard Scarr, (804) 484-6152. Founded 1975, 20 members, observatory with 10" Newtonian. Public viewing nights.

Portsmouth: Tidewater Community College Astronomical Society, Physics Dept., State Route 135, 23703, Aubrey Hartman, (804) 484-2121. Founded 1982, 50 members, observatory with 14" SCT. Monthly public nights. Hosts annual Tidewater Star Party.

Richmond: Richmond Astronomical Society, 2800 Cassaway Rd., Midlothian, 23112, Tom Bernhardt, (804) 379-2928. Founded 1949, 55 members, observatory with 7.5" & 13" scopes. Public viewing nights.

Roanoke: Roanoke Valley Astronomical Society, 3721 Colony Lane SW, 24018, Gary Close, (703) 989-3474.

Virginia Beach: Tidewater Amateur Telescope Makers, 677 Charlecote Dr., 23464, Don Wright, (804) 424-9430. Founded 1977, 20 members.

WASHINGTON

Bellingham: WACO–Whatcom Assoc. of Celestial Observers, 3700 Taylor Ave., 98226, Tom Masterson, (206) 734-5821. Founded 1988.

Centralia: Southwest Washington Astronomical Society, 2421 Leisure Lane, 98531, Carl M. Newton, (206) 736-6144. Founded 1975, 25 members.

Keyport: Olympic Astronomical Society, P.O. Box 458, 98345, James Sykes, (206) 698-0381. Founded 1968, 70 members.

GREAT "HOW-TO" BOOKS

Are you considering buying or building your own telescope? The type of telescope that will be best for you depends upon many factors. ☐ **Telescope Optics, Evaluation and Design $24.95** starts with the basics and goes on to explain the advantages and disadvantages for practically every type of telescope of interest to the amateur—the ☐ **Optional IBM-PC Telescope Design Software $24.95** check here ☐ for math coprocessor version. (sold only to purchasers of the book) enables you to design and raytrace your own custom telescope. If you decide to make a Newtonian or Cassegrainian telescope ☐ **How to Make a Telescope $19.95** has, for more than 30 years, been consistently rated as the most complete and accurate book on the subject. ☐ **Microcomputer Control of Telescopes, $19.95** is a comprehensive guide that provides both the theoretical and practical considerations to computer control of telescopes. For nearly 20 years and 200+ issues the *Maksotouv Circulars* covered a wide variety of topics of interest to the advanced amateur telescope maker. The best of these articles have been assembled into **Advanced Telescope Making Techniques,** ☐ **Volume 1 — Optics, $19.95,** ☐ **Volume 2—Mechanical, $19.95.**

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CLUBS

Richland: Tri-City Astronomy Club, P.O. Box 651, 99352, Barbara Rittmann, (509) 783-1845. Founded 1984, 45 members. Public viewing nights.

Seattle: Boeing Employees Astronomical Society, The Boeing Company, P.O. Box 3707, Mail Stop 4H-58, 98124, Walter Hazen, (206) 657-6488. Founded 1980, 100 members, 20" portable telescope.

Seattle: Seattle Astronomical Society, 14454 119th Place NE, Kirkland, 98034, Marjie Kichline, (206) 523-ASTR, 180 members.

Spokane: Spokane Astronomical Society, P.O. Box 8114, 99203-8114, Thom Jenkins, (509) 838-1381. Founded 1936, 85 members.

Tacoma: Tacoma Astronomical Society, 6103-132nd St. E., Puyallup, 98371, Keith McGowan, (206) 841-1126. Founded 1931, 85 members, observatory with 15" refractor. Monthly public viewing nights. Call 846-0788 for details.

Yakima: Yakima Valley Astronomy Club, 1108 S. 7th Ave., 98902, Mac Knight, (509) 457-6410. Founded 1990, 12 members. Regular public viewing sessions.

WEST VIRGINIA

Cross Lanes: Kanawha Valley Astronomical Society, 5204 Dellway Dr., 25313, Roger Chapman, 35 members.

Tridelphia: N.O.V.A.E., Box 436 Chapel Hill, 26059, (304) 547-5578. Founded 1989, 6 members.

WISCONSIN

Beloit: Rock Valley Astronomical Society, 2220 E. Ridge Rd., 53511, Carl Balke, (608) 362-0432. Founded 1950, 20 members.

Fall Creek: Chippewa Valley Astronomy Society, Hobbs Observatory, Route 2, Box 94, 54742, Bob Elliott, (715) 877-2787. Founded 1982, 25 members, observatory with 24" reflector. Hosts annual Northwoods Starfest.

Franklin: Wehr Astronomical Society, 9701 West College Ave., 53132, Karen Kerans, (414) 425-8550. Founded 1981, 117 members. Public star parties March-September at the Bong State Recreation Area.

Grafton: Northern Cross Science Foundation, 1327–11th Ave., 53024, William Fisher, (414) 377-0468.

Green Bay: Neville Museum Astronomical Society, 210 Museum Place, 54302, Don Dewitt, (414) 468-8945. Founded 1966, 50 members, observatory with 30" Cassegrain.

La Crosse: La Crosse Area Astronomical Society, P.O. Box 2041, 54602-2041, Robert Allen, (608) 785-8669. Founded 1978, 35 members.

Madison: Madison Astronomical Society Inc., 404 Prospect, Waunakee, 53597, Bob Manske, (608) 849-5287. Founded 1930, 75 members, observatory with 17.5" scope.

Milwaukee: Milwaukee Astronomical Society, W248 S7040 Sugar Maple Dr., Waukesha, 53186, Daniel Koehler, (414) 662-2987. Founded 1932, 350 members, observatory with 25.7" Cassegrain. Bi-weekly public viewing nights July-Oct. Phone 542-9071 for dates.

Oshkosh: NEWSTAR–Northeast Wisconsin Stargazers, 1815 Kienast Ave., 54901, Don Wyman, (414) 233-3083. Founded 1986, 45 members. Hosts Wisconsin Observer's Weekend.

Racine: Racine Astronomical Society, P.O. Box 085694, 53408-5694, Don Klemt, (414) 878-2774. Founded 1956, 60 members, Modine-Benstead Observatory with 16" scope. Public nights on Thursdays June-Aug.

Sheboygan Falls: Sheboygan Astronomical Society, 313 Main St., 53085, Kurt Peterson.

WYOMING

Casper: Central Wyoming Astronomical Society, 904 North Poplar St., 82601, Mark Hladik, (307) 577-0310. Founded 1989, 18 members.

Cheyenne: Cheyenne Astronomical Society, 6614 N. College #G, 82009, Marcy Curran, (307) 635-5944. Founded 1986, 88 members. Hosts annual Weekend Under the Stars.

CANADA

ALBERTA

Calgary: RASC–Calgary Centre, Alberta Science Centre, P.O. Box 2100, Station M, T2P 2M5, Glenn Hawley, (403) 237-7827. Founded 1958, 200 members, observatory with 14" scope. Public viewing nights. Co-hosts Alberta Star Party.

Edmonton: RASC–Edmonton Centre, 4203–106 B Ave., T6A LK7, Mel Rankin. Founded 1932, 120 members. Centre has 17.5" Dobson scope.

Fort McMurray: Astronomical Society of Fort McMurray, 113 Auger Court, T9J 1E5. Founded 1986, 10 members.

Lethbridge: Lethbridge Astronomy Society, P.O. Box 1104, T1J 4A2, Rick Ponomar, (403) 381-1332. Founded 1988, 30 members, observatory with 16" Ritchey-Chretien scope. Co-hosts annual Alberta Star Party.

BRITISH COLUMBIA

Clearbrook: Fraser Valley Astronomers Society, 2659 Valemont Crescent, V2T 3V6, Victor Pollack, (604) 850-3931. Founded 1987, 30 members.

Prince George: Prince George Astronomical Society, College of New Caledonia, 3330-22nd Ave., V2N 1P8, Bob Nelson, (604) 562-2131. Founded 1979, 15 members. Observatory with 61cm telescope.

Vancouver: RASC–Vancouver Centre, Gordon Southam Observatory, 1100 Chestnut St., V6J 3J9.

Vernon: Okanagan Astronomical Society, 4100 25th Ave., V1T 1P4, Peter Kuzel, (604) 545-1226, Hosts annual Mount Kobau Star Party.

Victoria: RASC–Victoria Centre, 801 Stanehill Place, RR #4, V8X 3W9, A. Newton, (604) 478-8065.

MANITOBA

Brandon: West-Man Astronomy Club, 32 Ashgrove Blvd., R7B 1C2, Jeff Harland, (204) 727-3111. Founded 1985, 35 members.

Winnipeg: Manitoba Astronomy Club, 190 Rupert Avenue, R3B 0N2, Gilbert Valentin, (204) 235-0065. Founded 1982, 40 members. Junior astronomers club. 24-hour Starline: (204) 988-0605.

Winnipeg: RASC–Winnipeg Centre, P.O. Box 215, St. James Post Office, R3J 3R4. Operates Glenlea Observatory (14" SCT).

NEWFOUNDLAND

Mount Pearl: RASC–St. John's Centre, P.O. Box 944, A1N 3C9, Peter Allston.

NOVA SCOTIA

Halifax: RASC–Halifax Centre, 1747 Summer St., B3H 3A6, Mary Lou Whitehorne, (902) 865-0235. Founded 1955, 140 members. Hosts annual Nova East Star Party.

Sydney River: Cape Breton Astronomical Society, 131 Green Acres Dr., B1S 1K5, John Reppa, (902) 562-2772. Founded 1986, 40 members. Hosts annual Highland Star Party.

ONTARIO

Kingston: RASC–Kingston Centre, P.O. Box 1793, K7L 5J6, Kim Hay, (613) 353-1189. Founded 1961, 40 members.

London: RASC–London Centre, P.O. Box 842, Station B, N6A 4Z3, Eric Clinton, (513) 453-3198. Founded 1922, 45 members.

Niagara Falls: RASC–Niagara Centre, P.O. Box 241, L2E 6T3, Gregory Saxon, (416) 732-5560. Founded 1958, 60 members, observatory with 17.5" scope. Public viewing nights.

Ottawa: RASC–Ottawa Centre, P.O Box 6617, Station J, K2A 3Y7, Douglas George, (613) 591-3119. Founded 1906, 250 members, observatory with 16" reflector.

Sarnia: RASC–Sarnia Centre, Emily St., Mooretown, N0N 1M0, Alice Lester. Founded 1980, 12 members.

Scarborough: Metropolitan Toronto Astronomical Society, 154 John Tabor Trail, M1B 2P8, S. Spinney.

Sudbury: Sudbury Astronomy Club, 859 Chestnut Crescent, P3A 5B3, Fred Boyer, (705) 560-3265.

Thunder Bay: RASC–Thunder Bay Centre, 135 Hogarth Street, P7A 7H1, Bob Bishop, (807) 767-5689. Founded 1987, 40 members.

Toronto: North York Astronomical Association, 26 Chryessa Ave., M6N 4T5. Founded 1980, 50 members, observatory with 16" Dobsonian. Hosts annual Starfest.

Toronto: RASC–Toronto Centre, McLaughlin Planetarium, 100 Queen's Park, M5S 2C6, B. Ralph Chou, (416) 777-4300. Founded 1868, 900 members.

Toronto: Students for the Exploration and Development of Space, P.O. Box 019, Rm. 308 Student Centre, York Univ., M3J 1P3, H. Peter White, (416) 650-9890. Founded 1987, 50 members.

Waterdown: RASC–Hamilton Centre, P.O. Box 1223, L0R 2H0, Pauline Wright, (416) 689-5717. Founded 1909, 90 members, observatory with 17" scope. Public viewing nights.

Waterloo: RASC–Kitchener-Waterloo Centre, 114 Westvale Dr., N2T 1J2, Paul Bigelow, (519) 888-7516. Founded 1980, 30 members, observatory with 12.5" scope. Group observing by reservation only.

Windsor: RASC–Windsor Centre, 5450 Haig Ave., N8T 1K9, Joady Ulrich, (519) 945-3132. Founded 1943, 50 members, observatory with 8" scope. Public viewing nights.

PRINCE EDWARD ISLAND

Summerside: Athena Community Astronomy Club, P.O. Box 2500, C1N 4L9, 50 members.

QUÉBEC

Longueuil: Club d'Astronomie De Longueuil, 941 des Pinsons, J4G 2L8, Gérald Brassard, (514) 359-9999. Founded 1985, 40 members, observatory with 16" scope.

Montréal: RASC–Le Societé d'Astronomie de Montreal, P.O. Box 206, Station St. Michel, H2A 3L9, Patrice Gerin-Roze, (514) 421-7300. Founded 1947, 230 members, observatory with 8" scope. Public viewing nights. Hosts annual CAFTA Conference, a Québec "Stellafane."

Montréal: RASC–Montréal Centre, P.O. Box 1752, Station B, H3B 3L3, Carole Talbot, (514) 845-2612. Founded 1918, 140 members, observatory with 14" SCT. Public viewing nights.

Montréal: Club d'Astronomie Espace de Montréal, 8530 boul. Lacordaire, Saint Leonard, H1R 2A7, François Quesnel, (514) 322-7587. Founded 1983, 20 members.

Sherbrooke: Club des Astronomes Amateurs de Sherbrooke, 1185 Bayeux, Luc Caya, (819) 562-3992. Founded 1981, 24 members.

Sorel: C.A.P. vers les étoiles, 323 rue Lapierre, J3P 5J1, Carl Miville, (514) 743-4710. Founded 1991, 19 members. Public viewing nights.

Ste. Foy: RASC–Quèbec Centre, Casier Postal 9396, G1V 4B5, Alain Daigle, (418) 832-4100. Founded 1942, 100 members, observatory with 14" SCT. Public viewing nights.

Trois-Rivières-Ouest: Club d'astronomie Jupiter, Inc., 5610 Marseille, G8Y 4M3, Thomas Collin, (819) 373-0266. Founded 1981, 25 members, observatory with 16" scope.

SASKATCHEWAN

Regina: RASC–Regina Centre, Box 20014, 2102 11th Ave., S4S 7E6, (306) 352-8515. Founded 1910, 30 members, observatory with 16" reflector. Public viewing nights.

Saskatoon: RASC–Saskatoon Centre, Box 317, Sub. P.O. Box #6, S7N 0W0, Mike Wesolowski, (306) 373-0137. Founded 1968, 45 members, observatory with 12.5" scope.

MEXICO

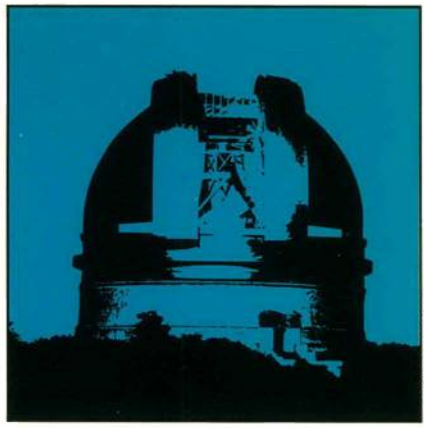
Mexico City, D.F.: Sociedad Astronómica de México, A.C., Isabel la Católica y Cádiz, Col. Alamos, Apartado Postal M-9647. Contact: Eric Roel; Phone: 519 47 30. Founded 1902, Observatories with 24" Cassegrain, 14" SCT, 12.5" reflector, 8" and 6"

Directory cover photos from top to bottom: Kitt Peak National Observatory, Arizona; National Museum of Science and Technology, Ottawa, Canada; Henry Buhl, Jr. Planetarium, Pittsburgh, Pennsylvania; *Smithsonian Astrophysical* Observatory, Arizona; Bob Bunge. Background photo by Brian Skiff.

ASTRONOMY PLACES

Whether you're looking for places to visit while you're on vacation or a source of information on things astronomical, our list of astronomy facilities should help you out. Our compilation contains 460 planetariums, observatories, nature centers, and science centers. From the information these facilities provided, ASTRONOMY estimates that the total annual attendance at astronomy-related attractions in North America is over 22 million people. In addition, nearly two-thirds (63 percent) of the attractions reported that their attendance increased over the last five years, indicating a growing public interest in astronomy and science.

If your local facility is not included on our list, please contact us so we can update our database.



Hale Observatories

UNITED STATES

ALABAMA

Birmingham: Robert R. Meyer Planetarium, Birmingham Southern College, Box A-36, 35254, (205) 226-4770, 30′ dome theater. Open 1st and 3rd Saturday and Sunday.

Florence: Planetarium and Observatory, Univ. of North Alabama, 35632, (205) 760-4284, 40′ dome theater (Spitz A3P), observatory (14.5" Newtonian). Planetarium open by reservation. Not open July & August. Program info. line: 760-4334.

Huntsville: The Space and Rocket Center, One Tranquility Base, 35807, (205) 837-3400, OMNIMAX® theater, visitor center for the Marshall Space Flight Center. Open daily.

Jacksonville: Jacksonville State University Planetarium, North Pelham Rd., 36265, (205) 782-5616, 20′ dome theater, observatory (12.5" telescope). Open by reservation.

ALASKA

Fairbanks: Geophysical Institute, Univ. of Alaska-Fairbanks, Elvey Building, 99775.

Juneau: Marie Drake Planetarium, 1250 Glacier Ave., 99801, (907) 586-3780.

ARIZONA

Amado: Multiple Mirror Telescope Observatory, P.O. Box 97, 85645, (602) 670-6741, Tours by reservation only. Also the site of the Fred Lawrence Whipple Observatory.

Flagstaff: Braeside Observatory, P.O. Box 906, 86002, (602) 774-4222, Open by reservation only.

Flagstaff: Lowell Observatory, 1400 W. Mars Hill Rd., 86001, (602) 774-3358, Observatory (24" Clark refractor), exhibits, tours. Open daily in summer. Program info. line: 774-2096.

Flagstaff: Northern Arizona Univ. Campus Observatory, Dept. of Physics & Astronomy, Box 6010, 86011-6010, (602) 523-2661, Observatory (24" reflector), exhibits, tours. Open Thursday night and also by reservation.

Flagstaff: U.S. Naval Observatory, P.O. Box 1149, 86002, (602) 527-7000.

Tucson: Flandrau Planetarium, Univ. of Arizona, Corner of Cherry and University Blvd., 85726, (602) 621-4515, 50′ dome theater (Minolta projector), observatory (16" Cassegrain), Cinema 360, laser shows, exhibits, tours. Open daily in summer. Program info. line: 621-STAR.

Tucson: Kitt Peak National Observatory, HC 04 Box 7520, 85735-9734, (602) 740-2426, Largest telescope is 4-meter Mayall. Visitor Center at summit: exhibits, tours, lectures, films. Open daily. Program info. line: 325-9200.

Tucson: Steward Observatory, Univ. of Arizona, 85721, (602) 621-2288.

ARKANSAS

Fayetteville: Univ. of Arkansas Planetarium, 117 Physics Building, 72701, (501) 575-2506, 20′ dome theater (Spitz A1), observatory (16" Cassegrain). Not open in summer. Open by reservation only.

Little Rock: Univ. of Arkansas-Little Rock Planetarium, 2801 South University Ave., 72204, (501) 569-3259, 40′ dome theater (Minolta Series II B), observatory (14.5" Cassegrain). Open Fri. at 7:30 p.m. and Sun. at 2:30 p.m. only. Program info. line: 569-3277.

CALIFORNIA

Apple Valley: Apple Valley Science and Technology Center, 15552 Wichita Rd., 92309, (619) 242-4115.

Aptos: Cabrillo College Planetarium, 6500 Soquel Dr., 95003, (408) 688-6466.

Berkeley: Lawrence Hall of Science, Univ. of California, 94720, (510) 642-5363, 25′ dome theater (Goto Venus), observatory (various scopes).Open daily in summer. Program info. line: 642-5362.

Big Bear City: Big Bear Solar Observatory, 40386 North Shore Lane, 92314, (714) 866-5791, Open Saturday afternoons 4 to 6 p.m. July-August.

Cassel: Hat Creek Radio Observatory, Univ. of California, Berkeley, Rt. 2, Box 500, 96016, (916) 335-2364, 85′ dish + three 20′ dishes. Open Mon.-Fri.

Chula Vista: Southwestern College Planetarium, 900 Otay Lakes Rd., 91910, (714) 421-6700, 30′ dome theater, observatory (12" scope). Open by reservation only.

Cupertino: Minolta Planetarium, 21250 Stevens Creek Blvd., 95014, (408) 864-8814, 50′ dome theater (Minolta), exhibits. Open daily in summer.

Edwards: Hugh L. Dryden Flight Research Facility, P.O. Box 273, 93523, (805) 258-3460, Visitor Center. Open 7:45 a.m.-3:45 p.m. weekdays. Tours at 10:15 and 1:15.

Eureka: College of the Redwoods Planetarium, Tompkins Hill Rd., 95501, (707) 445-6831, 14′ dome theater, observatory (14" scope). Not open in summer.

Fresno: Discovery Center, 1944 North Winery Ave., 93703, (209) 255-5533, Public observing Fri. evenings in summer. Open Tues.-Fri.

Los Angeles: California Museum of Science & Industry, Exposition Park, 700 State Dr., 90037, (213) 744-7483, Exhibits, IMAX® theater. Open daily.

Los Angeles: Griffith Observatory, 2800 East Observatory Rd., 90027, (213) 664-1181, 75′ dome theater (Zeiss Mark IV), observatory (12" Zeiss refractor), laser shows, exhibits, tours. Open daily in summer. Program info. line: 664-1191.

Los Angeles: Univ. of California-Los Angeles, U.C.L.A. Dept. of Astronomy, 405 Hilgard Ave., 90024-1562, (213) 825-4434, Planetarium, public observing. Not open in summer.

Moffett Field: NASA Ames Research Center, Mail Stop TO-27, 94035, (415) 604-6497, Exhibits, tours by reservation. Open Mon.-Fri. 9 a.m.-4:30 p.m.

Mount Hamilton: Lick Observatory, P.O. Box 55, 95140, (408) 274-5062, 120" and 40" reflectors, 36" refractor. Open daily, daytime only. Public observing through 40" and 36" on Friday nights July 6—August 31 by reservation only.

Oakland: Chabot Observatory and Planetarium, 4917 Mountain Blvd., 94619, (415) 531-4560, 30′ dome theater, 20" refractor, exhibits. Open Fri. and Sat. evenings.

Owens Valley: Owens Valley Radio Observatory, Robinson Laboratory, California Institute of Technology, Pasadena, 91125, (818) 356-4912.

Pasadena: Mount Wilson Observatory, Mount Wilson Institute, 740 Holladay Rd., 91106, (818) 793-3100, Historic 100" and 60" reflectors.

Pasadena: NASA Jet Propulsion Laboratory, 4800 Oak Grove, 91109, (818) 354-8593, Open 10 a.m.-3 p.m. weekdays by appointment only.

Pasadena: Palomar Observatory, California Inst. of Technology, 91125, (619) 742-2119, 200" Hale Telescope. Open daily in summer, daytime only.

Pleasant Hill: Diablo Valley College Planetarium, Astronomy Dept., 321 Golf Club Rd., 94553, (510) 685-1230, 24′ dome theater (Spitz A3P), observatory (18" Cassegrain). Not open in summer.

Redding: Schreder Planetarium, 1644 Magnolia Ave., 96001, (916) 225-0250, 33′ dome theater (Minolta II-B). Not open in summer. Program info. line: 225-0251.

Rohnert Park: Sonoma State Univ. Observatory, Dept. of Physics and Astronomy, 94928, (707) 664-2119, 14" telescope. Open one evening per month.

Sacramento: Sacramento Science Center, 3615 Auburn Blvd., 95821, (916) 277-6180, 30′ dome theater (Spitz A3P), exhibits. Open daily in summers except Mondays and Tuesdays. Program info. line: 485-8836.

San Bernardino: San Bernardino Valley College Planetarium, 701 South Mt. Vernon Ave., 92410, (714) 888-6511, 33′ dome theater (Goto G10), observatory (16" Cassegrain-Newtonian). Open by reservation only.

San Diego: Mount Laguna Observatory, Dept. of Astronomy, San Diego State Univ., 92182, (619) 594-6182, Obseratory (21" Cassegrain). Public nights Fri. & Sat. in summer and also by reservation.

San Diego: Reuben H. Fleet Space Theater and Science Center, 1875 El Prado, Balboa Park, 92101, (619) 238-1233, 76′ dome theater with planetarium shows, laser shows, OMNIMAX® films. Open daily.

San Diego: San Diego Aerospace Museum, 2001 Pan American Plaza, 92101, (619) 234-8291, Exhibits, tours. Open daily in summer.

San Francisco: Exploratorium, 3601 Lyon St., 94123, (415) 563-7337, Extensive science exhibits. Open daily in summer excepts Mon.

San Francisco: Morrison Planetarium, California Academy of Sciences, Golden Gate Park, 94118, (415) 750-7127, 65′ dome theater, laser shows, exhibits. Open daily in summer. Program info. line: 750-7141.

San Francisco: Planetarium Institute, San Francisco State Univ., Dept. of Astronomy and Physics, 94132, (415) 338-1852, 27′ dome theater (Spitz 512), observatory (16" Newtonian). Open by reservation only. Not open in summer.

San Jose: Rosicrucian Planetarium and Science Center, Park & Nagalee Ave., 95191-0001, (408) 287-9171, 50′ dome theater, exhibits. Open Tues.-Sun. daytime only.

San Marcos: Palomar College Planetarium, 1140 W. Mission Rd., 92069, (619) 744-1150, 30′ dome theater (Spitz A3P projector), exhibits, observatory (14" SCT). Not open in summer.

Santa Barbara: Gladwin Planetarium/Palmer Observatory, Santa Barbara Museum of Natural History, 2559 Puesta del Sol Rd., 93105, (805) 682-4711, 24′ dome theater (Spitz A3), observatory (5" to 29" scopes). Open daily in summer.

Santa Monica: Santa Monica College Planetarium, 1900 Pico Blvd., 90405, (310) 452-9223, 28′ dome theater (Minolta MS8), observatory (10" Schmidt-Cassegrain). Open Friday evenings and by reservation.

Santa Rosa: Santa Rosa Junior College Planetarium, 1501 Mendocino Ave., 95401, (707) 527-4640, 40′ dome theater. Program info. line: 527-4371.

Saratoga: West Valley College Planetarium, 14000 Fruitvale Ave., 95070, (408) 867-2200, 30′ dome theater. Open by reservation only.

Stockton: Clever Planetarium and Earth Science Center, San Joaquin Delta College, 5151 Pacific Ave., 95207, (209) 474-5051, 33′ dome theater (Spitz 512), Cinema 360°, exhibits. Open weekends by reservation only. Program info. line: 474-5110.

Walnut: Mt. San Antonio College Planetarium, 1100 North Grand Ave., 91789, (714) 594-5611.

COLORADO

Alamosa: Harry Zacheis Planetarium, Adams State

College, 81102, (719) 589-7616, Planetarium (Spitz P3), observatory (12"-17" scopes). Open by reservation only.

Boulder: Fiske Planetarium and Science Center, Univ. of Colorado, Regest Dr., 80309-0408, (303) 492-5002, 65′ dome theater (Zeiss VI), observatory (16" & 18" Cassegrains), exhibits. Open daily in summer except for Sat. and Sun. Program info. line: 492-5001.

Boulder: National Center for Atmospheric Research (NCAR), 1850 Table Mesa Dr., 80303, (303) 497-1174, Exhibits, tours, and printed materials offered. Open daily, daytime only. Guided tours Mon.-Sat. at noon. from June 4 till Labor Day.

Colorado Springs: Black Forest Observatory, 12815 Porcupine Lane, 80908, (719) 495-3828, Observatory (30" Cassegrain), tours. Open by reservation only.

Colorado Springs: U.S. Air Force Academy Planetarium, 5O ATS/DOP, 80840, (719) 472-2779, 50′ dome theater (Digistar projector). Open daily except Mondays in summer. Program info. line: 472-2778.

Denver: Chamberlin Observatory, Univ. of Denver, Dept. of Physics, 80208, (303) 871-2238, Observatory (20" refractor), tours, star parties. Public observing Tues. & Thurs. evenings by reservation only.

Denver: Gates Planetarium, Denver Museum of Natural History, 2001 Colorado Blvd., 80205, (303) 370-6317, 50′ dome theater (Minolta Series IV), observatory (22" telescope), IMAX®, laser shows, exhibits, tours. Open daily in summer. Program info. line: 370-6351.

CONNECTICUT

Avon: Talcott Mountain Science Center, Montevideo Rd., 06001, (203) 677-8571, Observatory with 12" reflector. Open year round to the public by appointment.

Danbury: Western Connecticut State College Planetarium, 06810, (203) 797-4218.

Middletown: Van Vleck Observatory, Wesleyan Univ., 06457, 9203) 347-9411, Not open in summer.

Mystic: Mystic Seaport Museum & Planetarium, P.O. Box 6000, Greenmanville Ave., 06355, (203) 572-0711, 30′ dome theater, public observing. Open daily in summer.

New Britain: Copernican Observatory and Planetarium, Central Connecticut State Univ., Wells St., 06050, (203) 827-7852, Open Fri. & Sat. evenings only.

New Haven: Southern Conn. State Univ. Planetarium, Fitch and Pine Rock Streets, 06515, (203) 397-4351, 24′ dome theater, observatory (12" scope). Open by reservation only. Not open in summer.

Stamford: Stamford Museum & Nature Center, 39 Scofieldtown Rd., 06903, (203) 322-1646, 22′ dome planetarium, exhibits, observatory (22" telescope). Open daily in summer.

Storrs: Univ. of Connecticut Planetarium, Physics Dept. U-46, 2152 Hillside Rd., 06269, (203) 486-4915, 16′ dome theater, observatory (6" refractor & 8" reflector). Open by reservation only.

West Hartford: Grengas Planetarium, Science Museum of Connecticut, 950 Trout Brook Dr., 06119, (203) 236-2961.

Willimantic: Robert C. Wickware Planetarium, Eastern Conn. State College, 83 Windham St., 06226, (203) 456-5300, 30′ dome theater (Spitz A4). Not open in summer.

DISTRICT OF COLUMBIA

Washington: National Air and Space Museum, 6th St. and Independence Ave., SW, 20560, (202) 357-1529, 70′ dome theater (Zeiss VIa), exhibits, tours, Albert Einstein Planetarium, IMAX® theater. Open daily in summer. Program info. line: 357-1686.

Washington: Rock Creek Nature Center, 5200 Glover Rd., N.W., 20015, (202) 426-6829, 24′ dome theater (Spitz A4), exhibits. Open daily.

Washington: U.S. Naval Observatory, 34th and Massachusetts Ave. NW, 20392, (202) 653-1543, 26" and 12" Clark refractors. Open Monday evenings only except federal holidays.

FLORIDA

Bradenton: Bishop Planetarium, 201 10th St. West, 34205, (813) 746-4132, 50′ dome theater (Spitz STP), observatory (f/12 6" refractor), laser shows, exhibits, tours. Open daily in summer except Mondays. Program info. line: 746-STAR.

Cape Canaveral: U.S. Air Force Space Museum, Cape Canaveral Air Force Station, 32925, (407) 853-3245, Open daily in summer. Included on Kennedy Space Center tour.

Cocoa: Astronaut Memorial Space Science Center, Brevard Community College, 1519 Clearlake Rd., 32922, (407) 631-7889, 40′ dome theater, observatory (24" Cassegrain). Cinema 360°, laser shows, exhibits. Public viewing Fri. & Sat.

Daytona Beach: Museum of Arts and Sciences Planetarium, 1040 Museum Blvd., 32014, (904) 255-0285, 40′ dome theater (Minolta MS10), exhibits. Open Tues.-Sun.

Ft. Lauderdale: Buehler Planetarium, Broward Community College, 3501 Southwest Davie Rd., 33314, (305) 475-6681, 40′ dome theater (Zeiss M1015), 16′ dome theater (Goto), observatory (10" scope), laser shows, exhibits , star lab. Open daily in summer. Program info. line: 475-6680.

Ft. Myers: Junior Museum and Planetarium, 3450 Ortiz Ave., 33906, (813) 275-3435, 40′ dome theater (Spitz 512), Cinema 360. Open daily in summer except Monday thru Wednesday.

Gainesville: Observatory, Univ. of Florida, 32601, (904) 392-2058, 12.5" telescope. Open Friday evenings only.

Jacksonville: Alexander Brest Planetarium, Jacksonville Museum of Sciences and History, 1025 Gulf Life Rd., 32207, (904) 396-7062, 60′ dome theater, exhibits, public observing. Open daily in summer.

Kennedy Space Center: Kennedy Space Center Spaceport USA, Mail Code TWRS, 32899, (407) 452-2121, IMAX® theater, exhibits, tours. Open daily.

Melbourne: Space Coast Science Center, 1510 Highland Ave., P.O. Box 36-1816, 32936, (407) 259-5572, Open Tues.-Sat.

Miami: Miami Space Transit Planetarium, 3280 South Miami Ave., 33129, (305) 854-4244, 65′ dome theater (Spitz STP), observatory (12.5" & 17.5" reflectors), exhibits, Spanish shows. Open daily in summer. Program info. line: 854-2222.

North Fort Myers: Milky Way Recreational Telescopes, 8249 Penny Dr., 33917, Conducts star parties for groups and schools by reservation.

North Palm Beach: South Florida Science Museum, 4801 Dreher Trail, 33405, (407) 832-1988, Includes Aldrich Planetarium.

Orlando: John Young Planetarium, Orlando Science Center, 810 East Rollins St., 32803, (407) 896-7151, 40′ dome theater (Minolta MS10 projector), observatory (14" scope), exhibits. Open daily.

Pensacola: Owens Planetarium, Pensacola Junior College, 1000 College Blvd., 32504, (904) 484-2054, 30′ dome theater. Open Thurs. evenings, Sept.-April only.

St. Augustine: Fountain of Youth Planetarium, 155 Magnolia Ave., 32084, (904) 829-6138, 30′ dome theater. Open daily.

St. Petersburg: Science Center of Pinellas Co. Planetarium, 7701 22nd Ave. North, 33710, (813) 384-0027, 16′ dome theater. Open by reservation only.

St. Petersburg: St. Petersburg Junior College Planetarium, P.O. Box 13489, 5th Ave. North at 69th St., 33710, (813) 341-4320, 24′ dome theater, observatory. Open Fri. evenings only.

Tallahasee: Observatory, Dept. of Physics, Florida A&M Univ., 14" telescope.

Tallahasee: Pat Thomas Planetarium, Florida State Univ., Dept. of Physics B-159, 32306, (904) 644-6822, 30′ dome theater (Spitz 512). Open by reservation only. Not open in summer.

Titusville: U. S. Astronaut Hall of Fame, Kennedy Space Center, 32780, (407) 269-6100.

GEORGIA

Albany: Wetherbee Planetarium, 100 Roosevelt Rd., 31701, (912) 435-1572, 20′ dome theater, exhibits. Open by reservation only.

Atlanta: Fernbank Science Center, 156 Heaton Park Dr. NE, 30307, (404) 378-4311, 70′ Jim Cherry Memorial Planetarium dome theater (Zeiss IV), observatory (36" Cassegrain), IMAX®, exhibits. Open daily in summer.

Columbus: Patterson Planetarium, 2900 Woodruff Farm Rd., 31907, (404) 568-1730, 40′ dome theater. Open by reservation only. Public observing weekly at Pine Mountain.

Dahlonega: North Georgia College, Physics Dept., 30597, (404) 864-1510, 30′ dome theater (Spitz 512), observatory (16" Cassegrain). Open by reservation only. Program info. line 864-1470.

Decatur: Agnes Scott College Planetarium/Bradley Observatory, Agnes Scott College, 30030, (404) 371-6265, 12′ dome theater, observatory (14" telescope). Open by reservation only. Not open in summer.

Fairmount: Sunrise Planetarium and Science Museum, Camp Sunrise, 1427 Slate Mine Rd. SE, 30139-2835, (706) 337-2776, 35′ dome theater (Goto Viewlex projector), exhibits. Planetarium open by reservation only.

Macon: Museum of Arts and Sciences, 4182 Forsyth Rd., 31210, (912) 477-3233, 40′ dome planetarium (Minolta MS10), observatory (14" scope), exhibits, tours. Open daily in summer.

Rock Spring: Walker County Science Center, P.O. Box 10, Highway 95, 30739, (404) 764-1111, 24′ dome theater (Spitz A3P), observatory (11" scope). Open by reservation only. Starnet BBS/FAX: 764-1629.

Savannah: Savannah Science Museum, 4405 Paulsen St., 31405, (912) 355-6705, 24′ dome theater (Spitz 512), exhibits, tours. Open daily in summer except Mondays and holidays.

Statesboro: Georgia Southern Univ. Planetarium, Box 8031, 30460, (912) 681-5292, 40′ dome theater. Not open in summer.

Valdosta: Valdosta State College Planetarium, Dept. of Physics, Astronomy and Geology, 31698, (912) 333-5752, 24′ dome theater, exhibits, observatory (16" scope). Open by reservation only. Not open in summer.

Young Harris: Rollins Planetarium, Young Harris College, 30582, (404) 379-3990, Open Fridays.

HAWAII

Hilo: Mauna Kea Observatory, Omizuka Center for International Astronomy, 177 Makaala St., 96720, (808) 935-3371, Observatory (11" SCT), exhibits, tours, AV programs. Public info. night and star gazing every Friday and Saturday. Program info. line: 961-2180.

Honolulu: Bishop Museum and Planetarium, 1525 Bernice St., P.O. Box 19000-A, 96817, (808) 848-4102, 30′ dome theater, exhibits, observatory (12" telescope). Open daily. Program info. line: 848-4136.

Honolulu: Mauna Kea Observatories, Institute for Astronomy, 2680 Woodlawn Dr., 96822, (808) 948-8312, Four-wheel drive vehicle recommended for drive to the summit of Mauna Kea on the Big Island. Visitor center at 9,000-foot level.

Kamuela: Canada-France-Hawaii Telescope, Mauna Kea, P.O. Box 1597, 96743, (808) 885-7944, 3.6-meter telescope. Viewing gallery.

IDAHO

Caldwell: Whettenberger Planetarium, College of Idaho, 2112 Cleveland, 83605, (208) 459-5011, Open by reservation only.

ILLINOIS

Bloomington: Observatory, Illinois Wesleyan Univ., 61702, (309) 556-3060, Observatory (16" Cassegrain). Open by reservation only.

Champaign: William M. Staerkel Planetarium, Parkland College, 2400 West Bradley Ave., 61821-1899, (217) 351-2568, 50′ dome theater (Zeiss M1015 projector), Cinema 360, public observing. Open daily in summer. Program info. line: 351-2446.

Chicago: Adler Planetarium, 1300 South Lake Shore Dr., 60605, (312) 322-0304, 68′ dome theater, exhibits, observatory (20" scope with CCD). Open daily in summer.

Chicago: Museum of Science & Industry and Crown Space Center, 57th St. and Lake Shore Dr., 60637, (312) 684-1414, Exhibits, OMNIMAX® theater. Open daily in summer.

Evanston: Dearborn Observatory, Northwestern Univ., 2131 Sheridan Rd., 60201, (708) 256-6639, 18" telescope. Public observing Friday evenings only by reservation.

Joliet: Herbert Trackman Planetarium, Joliet Junior College, 1216 Houbolt Ave., 60436, (815) 729-9020, Not open in summer.

Kankakee: Strickler Planetarium, Olivet Nazarene Univ., 60901, (815) 939-5395, 30′ dome theater (Spitz A4). Open by reservation only.

Normal: Illinois State Univ. Planetarium, College Ave. & School St., 61761-6901, (309) 438-8756, 30′ dome theater (Spitz A3P), laser shows, public observing. Open Mon.—Thurs evenings + Sat. mornings. Program info. line: 438-2496.

Peoria: Lakeview Museum of Arts and Sciences, 1125 West Lake Ave., 61614, (309) 686-7000, 33′ dome planetarium (Spitz 512 projector), exhibits. Program info. line: 686-NOVA.

River Grove: Cernan Earth & Space Center, Triton College, 2000 Fifth Ave., 60171, (312) 456-0300, 44′ dome theater (Spitz 512), Cinema 360°, laser shows, exhibits. Open daily in summer except Sun. Program info. line: 456-5815.

Rockford: Discovery Center Museum, 711 North Main St., 61103-6903, (815) 963-6769, 20′ dome theater (Spitz Nova II), exhibits, tours. Open daily in summer.

Rockford: Time Museum, 7801 East State St., 61108, (815) 398-6000, Extensive exhibits of historic timekeeping pieces, tours, films. Open Tues.-Sun. daytime only.

Urbana: Univ. of Illinois Observatory, 349 Astronomy Building, 1011 N. Springfield Ave., 61801, (217) 338-3090, 12" refractor.

INDIANA

Bloomington: Kirkwood Observatory, Indiana Univ., 47401, (812) 855-6911, 12" refractor. Open Wednesdays at dusk between Mar. 21 and Sept. 21. Planetarium open by reservation.

Evansville: Koch Science Center and Planetarium, Evansville Museum, 411 SE Riverside Dr., 47713, (812) 425-2406, 30′ dome theater (Spitz 512), exhibits. Open Tues.-Sun.

Evansville: Wahnseidler Observatory, P.O. Box 3474, 47733, (812) 922-5681, 14" telescope. Located in Lynnville City Park. Public viewing each Wed. and 3rd Fri.

Fort Wayne: E. C. Schouweiler Planetarium, Saint Francis College, 2701 Spring St., 46806, (219) 434-3278, 35′ dome theater (Spitz A4). Not open in summer. Star of Mexico July 5-15.

Greencastle: McKim Observatory, DePauw Univ., 46135, (317) 658-4654, 9.5" Clark refractor. Open by reservation only. Program info. line: 658-4661.

Indianapolis: Holcomb Observatory & Planetarium, Butler Univ., 4600 Sunset Ave., 46208, (317) 283-9282, 24′ dome theater (Spitz A3P), observatory (38" reflector), tours. Open daily in summer except Aug. Program info. line: 283-9333.

Indianapolis: Spacequest Planetarium, Children's Museum of Indianapolis, 3000 North Meridian St., 46208, (317) 924-5431, 40′ dome theater (Digistar projector), exhibits. Open daily in summer.

Marshall: Nature Center Planetarium, Turkey Run State Park, RR 1, Box 164, 47859, (317) 597-2654, 16′ dome theater. Open daily in summer.

Muncie: Ball State Univ. Planetarium, Dept. of Physics and Astronomy, Cooper Science Bldg., 47306, (317) 285-8860, 30′ dome theater (Spitz A3P projector), observatory (14" SCT). Open by reservation only.

Terre Haute: John C. Hook Memorial Observatory, Dept. of Geology and Geography, Indiana State Univ., 47802, (812) 237-6300, Various telescopes. Open Tues. & Fri. evenings.

Vincennes: Dunseth Planetarium, Vincennes Univ. Community College, 47591, (812) 885-4229, 40′ dome theater (Viewlex Mercury projector). Open by reservation only.

IOWA

Cedar Falls: Hillside Observatory, Univ. of Northern Iowa, Dept. of Earth Sciences, 50614, (319) 273-2759, Observatory (16" reflector). Not open in summer. Program info. line: 273-6063.

Cherokee: Sanford Museum and Planetarium, 117 East Willow St., 51012, (712) 225-3922, 18′ dome theater, exhibits. Open last Sunday of each month.

Decorah: Luther College Planetarium, Physics Dept., 700 College Dr., 52101, (319) 387-1712, 20′ dome theater (Spitz AP3), tours. Open by reservation only. Program info. line: 387-1117.

Des Moines: Drake Univ. Observatory, Drake Univ., 50311, (515) 271-3141, Open Friday evenings.

Des Moines: Science Center of Iowa/Sargent Planetarium, 4500 Grand Ave., 50312, (515) 274-6868, 40′ dome theater (Digistar projector), exhibits. Program info. line: 274-4138.

Dubuque: Heitkamp Memorial Planetarium, Loras College, Dept. of Physics, 52001, (319) 588-7100, 30′ dome theater (Goto Venus). Open Friday evenings. Not open in summer.

Sioux City: Briar Cliff College Planetarium, 3303 Rebecca St., 51104, 17′ dome theater (Spitz A-1), exhibits. Open daily in summer except holidays. Planetarium programs by reservation only.

Waterloo: Grout Museum of History and Science, 503 South St., 50701, (319) 234-6357, 15′ dome planetarium (Spitz 373 projector), exhibits. Open Tues.-Sat.

KANSAS

Emporia: Peterson Planetarium, Emporia State Univ., 1200 Commercial, 66801, (316) 341-5980, 30′ dome theater (Spitz A3P). Open by reservation only. Not open in summer.

Great Bend: Barton County Community College Planetarium, Bissells Point Rd., 67530, (316) 792-2701. Open by reservation only.

Greensburg: Pallasite Meteorite, The Big Well, 315 South Sycamore, 67054, (316) 723-2261. Open daily.

Hutchinson: Kansas Cosmosphere & Space Center, 1100 North Plum St., 67501, (316) 662-2305, 30′ dome theater (Spitz A3P), OMNIMAX®, exhibits. Open daily.

Salina: Kansas Weslayan Univ. Observatory, 100 E. Claflin, 67401, (913) 827-5541, 16" Cassegrain. Monthly public nights. Also open by reservation

Topeka: Washburn Univ. Planetarium, 17th and College, 66621, (913) 231-1010 x1330, 20′ dome theater (Viewlex Mercury), observatory (12" refractor). Open by reservation only.

Wichita: Lake Afton Public Observatory, 1845 Fairmount, 67208, (316) 689-3191, Observatory (16" Cassegrain). Open Fri., Sat. & Sun. evenings during summer. Program info. line: 794-8995.

Wichita: Omnisphere and Science Center, 220 South Main St., 67202, (316) 264-3174, 30′ dome theater. Open Tues.-Sun. Program info. line: 264-6178.

KENTUCKY

Berea: Weatherford Planetarium, Berea College, CPO 2326, 40404, (606) 986-9341, 30′ dome theater, observatory (16" telescope). Open Sat. and Sun. afternoons only.

Georgetown: Georgetown College Planetarium, 400 E. College St., 40324-1696, (502) 863-8436, 35′ dome theater. Open by reservation only.

Golden Pond: Golden Pond Planetarium, Tennessee Valley Authority, Land Between the Lakes, 42211, (502) 924-5602, 40′ dome theater (Spitz 512). Open daily in summer.

Louisville: Museum of History & Science, 727 West Main St., 40202, (502) 561-6103, Exhibits, IMAX® theater. Open daily in summer.

Louisville: Rauch Memorial Planetarium, Univ. of Louisville, Belknap Campus, 40292, (502) 588-6665, 30′ dome theater (Spitz 512A). Open daily in summer.

Richmond: Arnim D. Hummel Planetarium, Eastern Kentucky Univ., 40475, (606) 622-1547, 67′ dome theater (Spitz Space Voyager projector). Open daily in summer.

LOUISIANA

Baton Rouge: Louisiana Arts and Science Center Planetarium, 502 North Blvd., 70821, (504) 344-9465. Open Tues.-Sun.

Kenner: Freeport McMoran Daily Living Science Center, 409 Williams Blvd., 70062, (504) 468-7229, 26′ dome theater (Spitz A3P), observatory (14" SCT). Open daily in summer except Mon.

Lafayette: Natural History Museum and Planetarium, 637 Girard Park Dr., 70503, (318) 268-5544, 30′ dome theater (Spitz A4), exhibits, public observing. Open daily in summer.

Luling: St. Charles Parish Library Planetarium, 91 Lakewood Dr., 70070, (504) 785-8471, 20′ dome theater, public observing. Open Mon.-Sat.

New Orleans: Louisiana Nature and Science Planetarium, Joe W. Brown Memorial Park, P.O. Box 870610, 70187, (504) 246-5672, 30′ dome theater (Spitz A4), exhibits, laser shows. Open daily in summer. Program info. line: 246-7827.

MAINE

Castine: Planetarium, Maine Maritime Academy, 04420, (207) 326-4311.

Easton: Francis Malcolm Science Center Planetarium, P.O. Box 186, U.S. Route 1-A, 04740, (207) 488-5451, 24′ dome theater (Spitz 373). Not open in summer.

Fairfield: Northstar Mobile Planetarium, 04937, (207) 453-7668.

Lewiston: Bates College Planetarium, Dept. of Physics & Astronomy, 04240, (207) 786-6320.

Orono: Univ. of Maine Planetarium, Wingate Hall, 04469, (207) 581-1341, 20′ dome theater (Spitz 373), observatory (8" refractor). Open by reservation only.

Portland: Southworth Planetarium, Univ. of So. Maine, 96 Falmouth St., 04103, (207) 780-4249, 30′ dome theater (Zeiss Jena ZKP2), exhibits, laser shows, public observing. Open daily in summer. Astronomy Hotline: 780-4719.

MARYLAND

Annapolis: McKeldin Memorial Planetarium, St. John's College, 60 College Ave., 21401, (301) 263-2371, 24′ dome theater.

Annapolis: Planetarium, U.S. Naval Academy, Luce Hall Seanav, 21402, (301) 267-3952, 40′ dome theater (Goto MK 12). Open by reservation only.

Baltimore: Community College of Baltimore Planetarium, 2901 Liberty Heights Ave., 21215, (301) 396-7994, Open by reservation only.

Baltimore: K. Brice Bryan Planetarium, College of Notre Dame, 4701 N. Charles St., 21210, (301) 435-0100, 20′ dome theater (Nova II), observatory (10" Newtonian). Open by reservation only. Program info. line: 532-5702.

Baltimore: Maryland Science Center, Davis Planetarium, 601 Light St., 21230, (410) 685-2370, 50′ dome theater (Minolta MS15), IMAX® theater, exhibits. Open daily in summer. Program info. line: 685-5225, STARLINE: 539-STAR.

Baltimore: Space Telescope Science Institute, 3700 San Martin Dr., 21218, (301) 338-4700, Open by reservation only for group tours.

College Park: Univ. of Maryland Observatory, 1205 Space Sciences Building, 20742, (301) 454-3001, Observatory (7"-20" scopes), slide shows and public observing. Open 5th and 20th of each month in evening.

Frostburg: Frostburg State Univ. Planetarium, Tawes Hall Lobby, Frostburg State Univ., 21532, (301) 689-4298, 24′ dome theater (Spitz A4). Open by reservation only.

Greenbelt: NASA Goddard Space Flight Center, 20771, (301) 286-8981, Visitor Center, tours by reservation. Open Wed.-Sun. 10 a.m.- 4 p.m.

Hagerstown: Washington County Planetarium, 823 Commonwealth Ave., 21740, (301) 791-4172, 30′ dome theater (Spitz A4RPY projector). Not open in summer.

Takoma Park: Montgomery College Planetarium, Takoma Ave. & Fenton St., 20912, (301) 650-1463, 24′ dome theater (Spitz 512), observatory (3.5 and 8" scopes). Open by reservation only.

MASSACHUSETTS

Amherst: Bassett Planetarium and Wilder Observatory, Amherst College, Dept. of Astronomy, 01002, (413) 542-2138, 30′ dome theater (Spitz A3P), observatory (18" Clark refractor). Public observing at 9:00 p.m. on clear Sat. evenings by reservation only.

Amherst: Orchard Hill Observatory, Univ. of Massachusetts, 01002, (413) 545-0111, 20" Cassegrain. Open by reservation only.

Boston: Boston Univ. Dept. of Astronomy Observatory, 725 Commonwealth Ave., College of Liberal Arts, 02215, (617) 353-5700, 14" and 12" telescopes. Open every clear Wed. night. Call 353-2630 after 5:30 p.m. Wed. to confirm.

Boston: Charles Hayden Planetarium, Boston Museum of Science, 02114-1099, (617) 589-0270, 60′ dome theater, OMNIMAX®. Open daily in summer. Program ino line: 723-2500.

Cambridge: Harvard-Smithsonian Center for Astrophysics, 60 Garden St., 02138, (617) 495-7461, 9" Clark refractor. Public observing on third Thursday evening each month. Sky Info. line: 491-1497.

Cambridge: Wallace Observatory, Massachusetts Institute of Technology, Building 54-426, 02139, (617) 253-7568, 24" telescope. Open by reservation only.

Deerfield: Andrews Planetarium, Deerfield Academy, 01342, (413) 772-0241, 40′ dome theater (Viewlex Mark IIB), observatory (10" cassegrain). Open by reservation only.

Fall River: Durfee High Planetarium/Observatory, 360 Elsbree St., 02720, (508) 675-8100, 26′ dome theater. Observatory open one night per month to public Sept. thru. June.

Nantucket: Maria Mitchell Association, 2 Vestal St., 02554, (508) 228-9198, Public observing Wed. evenings July and Aug. only. Program info. line: 228-9273.

Norton: Wheaton College Observatory, Dept. of Physics and Astronomy, Wheaton College, 02766, (509) 285-7722, 14" and 8" telescopes. Open clear Thurs. evenings when college is in session.

Quabbin: Five College Radio Observatory, University of Massachusetts, Amherst, 01002, (413) 545-2194, 14-meter radio telescope. Open by restricted reservation.

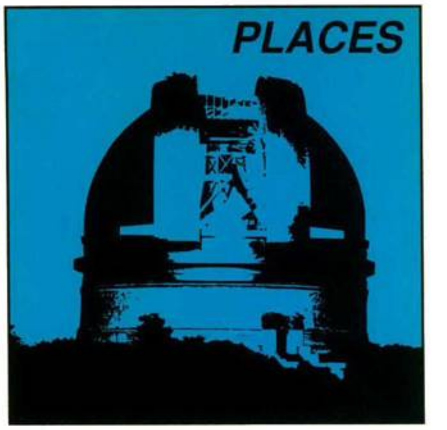
Springfield: Springfield Science Museum, 236 State St., 01103, (413) 733-1194, Exhibits, 33′ dome planetarium, observatory (20" reflector). Open afternoons only, Thurs.—Sun.

Wenham: Woodside Planetarium and Observatory, 13 Friend Court, 01984, (508) 468-4815, 14′ dome theater, observatory (14" SCT). Not open in summer. Open by reservation only.

Westford: Haystack Observatory, Route 40, 01886, (508) 692-4764, Radio telescope. Tours by reservation. Open house in October.

Whatley: Whatley Observatory, Univ. of Massachusetts, 01002, (413) 545-0111, 20" infrared Cassegrain. Open by restricted reservation.

Williamstown: Hopkins Observatory/Milham Planetarium, Williams College, Main St., 01267, (413) 597-2105, 16′ dome theater (Spitz A3P), observatory (24" scope).



Open by reservation only. Program info. line: 597-2188.

Worchester: New England Science Center, 222 Harrington Way, 01604, (617) 791-9211, 40' dome planetarium, exhibits, observatory (14" scope). Open daily.

MICHIGAN

Alpena: Jesse Besser Museum and Planetarium, 491 Johnson St., 49707, (517) 356-2202, 33' dome theater, exhibits. Open daily in summer, daytime only.

Ann Arbor: Exhibit Museum Planetarium, 1109 Geddes Ave., 48109-1079, (313) 747-1381, 18' dome theater, exhibits. Open Tues.-Sun. Program info. line: 764-0478.

Battle Creek: Gardner Memorial Planetarium, Kingman Museum of Natural History, West Michigan Ave. at 20th St., 49017, (616) 965-5117, 16' dome theater (Viewlex Apollo), exhibits. Open daily in summer.

Bloomfield Hills: Cranbrook Institute of Science, 500 Lone Pine Rd., P.O. Box 801, 48303, (313) 645-3230, 30' dome theater—McMath Planetarium (Spitz 512), Hulbert Observatory (6" refractor), laser shows. Open daily in summer. Program info. line: 645-3200.

Detroit: Children's Museum/Detroit Public Schools, 67 East Kirby, 48202, (313) 494-1210, Exhibits, planetarium shows. Open daily in summer.

Detroit: Detroit Science Center, 5020 John R St., 48202, (313) 577-8430, Exhibits, planetarium shows, laser shows, OMNIMAX® theater, public observing. Open Tues.—Sun.

East Lansing: Abrams Planetarium, Michigan State Univ., 48824-1324, (517) 355-4676, 50' dome theater (Spitz STP), exhibits, observatory (24" scope). Program info. line: 355-4672.

Flint: Robert T. Longway Planetarium, 1310 East Kearsley St., 48503, (313) 760-1181, 60' dome theater (Spitz B), exhibits, laser shows. Public shows every weekend and also open by reservation.

Grand Rapids: Roger B. Chaffee Planetarium, Grand Rapids Public Museum, 54 Jefferson, S. E., 49503, (616) 456-3985, 30' dome theater (Goto), laser shows, exhibits, tours. Open weekends in June and daily July-Aug. Program info. line: 456-3200.

Jackson: Michigan Space Center, 2111 Emmons Rd., 49201, (517) 787-4425.

Jackson: Michigan Space Center, Jackson Community College, 2111 Emmons Rd., 49201, (517) 787-4425, Space museum open daily.

Kalamazoo: Kalamazoo Public Museum Planetarium, 315 South Rose St., 49007, (616) 345-7092, 30' dome theater (Spitz A4), observatory (8" Newtonian), exhibits. Open daily in summer. Program info. line: 382-6873.

Lansing: Impression Five Science Museum, 200 Museum Dr., 48933, (517) 485-8116, Interactive exhibits. Open daily.

Lansing: Lansing Community College Planetarium, 419 N. Capitol Ave., 48910, (517) 373-7284, 39' dome theater, observatory (10" telescope), exhibits. Open by reservation only.

Lowell: James C. Veen Observatory, 3308 Kissing Rock Rd. SE, 49331, (616) 456-3985, Observatory (11"-17" scopes). Public observing 2nd Sat. & last Fri., Apr.-Oct. Open House Week Aug. 2-8. Program info. line: 897-7065.

Marquette: Shiras Planetarium, 1203 West Fair Ave., 49855, (906) 225-4250, 30' dome theater. Open Mon. and Wed. only. Program info. line: 225-4204.

Mount Pleasant: Brooks Observatory, Physics Dept., Central Michigan Univ., 48859, (517) 774-3321, Observatory (14" SCT). Open one Thurs. evening per month during academic year.

Muskegon: Carr-Fles Planetarium, Muskegon Community College, 221 S. Quarterline Rd., 49442, (616) 777-0289, 24' dome theater (Spitz A3P). Pubic shows Tues. and Thurs. 7:00 p.m. Jan.-June. Not open in summer.

Ypsilanti: Sherzer Observatory, Physics & Astronomy Dept., 303 Strong Hall, Eastern Michigan Univ., 48197, (313) 487-4144, Observatory (10" refractor), tours. Open by reservation only. Program info. line: 487-3033.

MINNESOTA

Duluth: Alworth Planetarium, 10 Univ. Dr., Univ. of Minnesota-Duluth, 55812, (218) 726-7129, 32' dome theater (Spitz A3P), exhibits. Free public shows Wed. 7:00 p.m.

Hibbing: Paulucci Space Theater, Arrowhead Community College Region, Hwy 169 & East 23rd St., 55746, (218) 262-6718, 40' dome theater (Spitz 512 projector), Cinema 360. Open daily in summer.

Marshall: Southwest State Univ. Planetarium, 56258, (507) 537-6178, 30' dome theater (Spitz 512 projector). Not open in summer.

Minneapolis: Minneapolis Planetarium, 300 Nicollet Mall, 55401, (612) 372-6543, 40' dome theater, laser shows. Open daily in summer.

Moorhead: Moorhead State Univ. Planetarium, 8th Ave. and 11th St. S, 56563, (218) 236-3982, 30' dome theater, monthly public observing. Open Thurs. evenings and by reservation.

New Ulm: Dr. Martin Luther College, 1884 College Heights, 56073, (507) 354-8221, 12' dome theater, observatory (17" scope). Open by reservation only.

St. Cloud: SCSU Observatory and Planetarium, St. Cloud State Univ., MS 324, 56301, (612) 255-2011, 30' dome theater (Spitz 512), observatory (8" and 17" SCT). Open by reservation only.

St. Paul: Macalester College Planetarium, 1600 Grand Ave., 55105, (612) 696-6000, 22' dome theater, observatory (25" telescope). Not open to public.

St. Paul: Science Museum of Minnesota/McKnight Omnitheater, 30 E. 10th St., 55101, (612) 291-9403, Exhibits, OMNIMAX® theater. Open daily.

MISSISSIPPI

Bay St. Louis: NASA John C. Stennis Space Center, Stennis Space Center, 39529, (601) 688-2370, Visitor Center, exhibits, tours. Open daily 9 a.m.-5 p.m.

French Camp: Rainwater Observatory and Planetarium, French Camp Academy, 39745, (601) 547-6113, 20' dome theater (Observadome projector), observatory (30" Newtonian). Open by reservation.

Jackson: Ronald E. McNair Space Theater, Russell Davis Planetarium, 201 East Pascagoula St., 39201, (601) 960-1550, 62' dome theater, laser shows, Cinema 360, exhibits. Open daily in summer.

Oxford: Kennon Observatory, Univ. of Mississippi, Dept. of Physics and Astronomy, 38677, (601) 232-7046, 15" refractor. Open by reservation only.

MISSOURI

Columbia: Laws Observatory, Dept. of Physics & Astronomy, Univ. of Missouri, 65211, (314) 882-3335, Observatory (16" scope). Open Fri. evening in summer.

Kansas City: Kansas City Museum Planetarium, 3218 Gladstone Blvd., 64123, (816) 483-8300, 20' dome theater (Apollo Viewlex projector), exhibits. Open daily in summer. Program info. line: 483-STAR.

St. Louis: St. Louis Science Center, 5050 Oakland Ave., 63110, (314) 289-4400, 60' dome planetarium (Digistar projector), OMNIMAX® theater, exhibits, public observing with 14" SCT. Open daily in summer. Program info. line: 289-4444.

MONTANA

Bozeman: Taylor Planetarium, Museum of the Rockies, Montana State Univ., 59717, (406) 994-2251, 40' dome theater (Digistar projector), public observing. Open daily in summer.

NEBRASKA

Chadron: Chadron State College Planetarium, 10th & Main St., 69337, (308) 432-6236, 25' dome theater, exhibits. Open by reservation only.

Fremont: Lueninghoener Planetarium, Midland Lutheran College, 900 N. Clarkson, 68025, (402) 721-5480 x6328, 30' dome theater (Spitz A3P), observatory (11" scope). Open by reservation only.

Hastings: J. M. McDonald Planetarium, 1330 North Burlington Ave., 68901, (402) 461-2399, 24' dome theater (Minolta MS8), observatory (10" & 14" scopes), exhibits. Planetarium open daily in summer, observatory open by reservation only.

Kearney: Bruner Hall of Science Planetarium, Kearney State College, 68849, (308) 234-8277, 24' dome theater, observatory (16" telescope). Open by reservation only.

Lincoln: Behlen Observatory, Dept. of Physics & Astronomy, Univ. of Nebraska, 68588-0111, (402) 472-2788, Observatory (30" Cassegrain). Public nights twice yearly–call for info. Open for group reservations.

Lincoln: Hyde Memorial Observatory, South Shore Rd.–Holmes Park, 68506, (402) 471-7960, Observatory (14" Schmidt-Cassegrain) Open Sat. evenings and by group reservation. Program info. line: 471-7094.

Lincoln: Jensen Planetarium, Nebraska Wesleyan Univ., 5000 Saint Paul Ave., 68504-2796, (402) 465-2246, Observatory for educational purposes only. Not open to public.

Lincoln: Mueller Planetarium, Univ. of Nebraska State Museum, 213 Morrill Hall, 68588-0338, (402) 472-2641, 34' dome theater (Spitz A4RP4), laser shows. Open Tues.-Sun.

Omaha: Durham Science Center and Kountze Planetarium, Univ. of Nebraska at Omaha, 68th and Dodge St., 68182, (402) 554-3727, 33' dome theater, laser shows, observatory. Open Fri.-Sun. only.

Wayne: Fred G. Dale Planetarium, Wayne State College, Box 77 W.S.C., 68787, (402) 375-7000, 30' dome theater (Spitz A4). Open by reservation only.

NEVADA

Las Vegas: Community College of Southern Nevada Planetarium, 3200 E. Cheyenne Ave., 89030, (702) 643-6060, 30' dome theater (Spitz 512), observatory (8" SCT), Cinema 360°, tours. Open daily in summer. Program info. line: 644-5059.

Reno: Fleischmann Planetarium, Univ. of Nevada-Reno, 1650 N. Virginia St., 89557, (702) 784-4812, 30' dome theater, Cinema 360, exhibits, public observing. Open daily in summer.

NEW HAMPSHIRE

Concord: Christa McAuliffe Planetarium, 3 Institute Dr., 03301, (603) 271-7831, 40' dome theater (Digistar projector), observatory (13" Dobsonian), exhibits. Open Tues.—Sun. Program info. line: 271-STAR.

Durham: Univ. of New Hampshire Observatory, DeMeritt Hall, 03801, (603) 862-1950, 14" telescope. Open every other Fri. all year.

Hanover: Shattuck Observatory, Dartmouth College, Physics and Astronomy Dept., Wilder Hall, 03755, (603) 646-2034, Open by reservation only.

Plymouth: Plymouth State College Planetarium, Boyd Hall, 03264, (603) 535-2325, 20' dome theater (Nova II), public shows first Monday. Not open in summer.

NEW JERSEY

Mountainside: Trailside Nature and Science Center, Coles Ave. and New Providence Rd., 07092, (908) 789-3670, 20' dome theater (Nova II). Open Sun. and also by reservation.

Newark: Newark Museum Planetarium, 49 Washington St., 07101, (201) 596-6610, 30' dome theater, public observing. Open daily in summer.

Randolph: County College of Morris Planetarium, Route 10 and Center Grove Rd., 07869, (201) 328-5755, 33' dome theater, public observing. Open by reservation only.

Toms River: Robert J. Novins Planetarium, Ocean County College, 08754-2001, (201) 255-0343, Shows Fri., Sat. & Sun. until June 9. Shows Tues.—Fri. after July 9. Program info. line: 255-0342.

Trenton: New Jersey State Museum Planetarium, 205 West State St., CN 530, 08625, (609) 292-6333, 40' dome theater, exhibits. Open daily in summer, daytime only.

NEW MEXICO

Alamogordo: Clyde W. Tombaugh Space Theater, Top of Highway 2001, 88310, (505) 437-2840, 40' dome theater (Spitz 512), OMNIMAX®, laser shows, exhibits. Open daily in summer. Program info. line (800) 545-4021.

Albuquerque: Univ. of New Mexico Observatory, Institute for Astrophysics, 800 Yale Blvd. NE, 87131, (505) 277-2616, 12" Maksutov. Open Fri. evenings. Not open in summer.

Farmington: San Juan College Planetarium, San Juan College, 4601 College Blvd., 87402, (505) 599-0361, 24' dome theater (Spitz 373). Not open in summer.

Roswell: Robert H. Goddard Planetarium, Roswell Museum & Art Center, 11th & North Main, 88201, (505) 624-6744, 40' dome theater (Spitz A4), exhibits, tours. public observing. Open daily in summer. Groups reservation for 15+ available.

Sapello: Star Hill Inn, 87745, (505) 425-5605, 14" SCT and many other telescopes available to guests of Inn. Retreat for amateur astronomers. Open daily in summer by reservation only.

Socorro: Very Large Array, National Radio Astronomy

Observatory, P.O. Box O, 87801-0387, (505) 835-7000, 27 element array of 85’ dishes, exhibits, self-guided tours. Open daily from 8:30 a.m. to sunset.

Sunspot: Apache Point Observatory, P.O. Box 59, 88349, (505) 437-6822, Open by reservation only.

Sunspot: ARC Telescope, N. M. State Univ., Dept. of Astronomy, Box 30001, Dept. 45000, Las Cruces, 88003, (505) 646-4438, ARC Telescope open daily in summer.

Sunspot: National Solar Observatory, Sacramento Peak, 88349, (505) 434-7000, 64" telescope, guided tours every Sat. at 2pm. Open daily, daytime only.

NEW YORK

Alfred: Observatory, Alfred Univ., 14802, (607) 871-2208, 20" and 32" telescopes. Open clear Thurs. evenings May-July.

Binghamton: Roberson Center for the Arts and Sciences/Link Planetarium, 30 Front St., 13905, (607) 772-0660, 30’ dome theater (Spitz A3P), observatory (14" scope), laser shows, exhibits, tours, star parties. Planetarium open Tues.-Sun.

Bronx: Northeast Bronx Planetarium, 750 Baychester Ave., 10475, (212) 379-1600, 40’ dome theater (Spitz A4 RPY). Open by reservation only. Not open in summer. Program info. line: 379-1616.

Brooklyn: Edwin P. Hubble Planetarium, 1600 Ave. L, 11230, (718) 258-9283, 24’ dome theater (Goto Mercury S1). Open by reservation only.

Buffalo: Whitworth/Ferguson Planetarium, Buffalo State Collage, 1300 Elmwood Ave., 14222, (716) 878-4911, 24’ dome theater (Spitz 512) observatory (10" Dobsonian). Open by reservation only.

Centerport: Vanderbilt Planetarium, 180 Little Neck Rd., 11721, (516) 262-7800, 60’ dome theater, exhibits, observatory (16" Cassegrain). Open daily in summer. Program info. line: 262-STAR.

Geneseo: Observatory at SUNY College, Dept. of Physics-Astronomy, 209 Greene Science Building, 14454, (716) 245-5282, 14" telescope. Open Fri. evenings by reservation only. Not open in summer.

Herkimer: Herkimer County BOCES Planetarium, 400 Gros Blvd., 13350, (315) 867-2000, 33’ dome theater (Minolta MS8), mobile solar video observatory. Public observing 2nd Wednesday and open by reservation.

Ithaca: Cornell Univ. Observatory, Dept. of Astronomy, Space Sciences Bldg., 14853, (607) 255-4935, 14" and 12" telescopes. Public observing Friday evenings.

Ithaca: Spacecraft Planetary Imaging Facility, Cornell Univ., 317 Space Sciences Building, 14850-6801, (607) 255-3833, Tours; can supply address lists of planetary picture suppliers but is not a distribution center. Open daily in summer 9am—4:30pm.

Middle Island: Longwood District Planetarium, 41 Yaphank Middle Island Rd., 11953, (516) 345-2741, 30’ dome theater (Goto Venus). Open by reservation only.

N. Massapequa: Plainedge School District Planetarium, Packard Middle School, Central Dr. & Idaho Ave., 11758, (516) 755-5723, 24’ dome theater (Spitz A3P), observatory (6" reflector). Open by reservation only.

New Paltz: John R. Kirk Planetarium, State Univ. College, CSB 28, 12561, (914) 257-3818, 24’ dome theater, observatory (8" scope). Open by reservation only. Not open in summer.

New York: American Museum/Hayden Planetarium, Central Park West at 81st St., 10024-5192, (212) 769-5900, 75’ dome theater (Zeiss VI), exhibits, lectures, concerts, children’s program, courses. Open daily in summer.

New York: City College of New York Planetarium, Science & Physics Building, 138th St. & Convent Ave., 10031, (212) 650-6832, 30’ dome theater (Spitz 512). Open by reservation only.

New York: New York Hall of Science, 47-01 111th St., Flushing Meadows–Corona Park, 11368, (718) 699-0005, Exhibits, Starlab portable planetarium. Open daily in summer.

Poplar Ridge: Southern Cayuga Planetarium, Route 34B, 13139, (315) 364-7111, 30 dome theater, exhibits, public observing. Open by reservation only.

Potsdam: Potsdam College Planetarium, Pierrepont Ave., 13676, (315) 267-2284, 24’ dome theater (Spitz A3P). Open by reservation only. Program info. line: 267-2286.

Rochester: C.E.K. Mees Observatory, Univ. of Rochester, Dept. of Physics and Astronomy, 14627, (716) 275-0539, Observatory (24" Cassegrain), tours. Open by reservation only.

Rochester: Strasenburgh Planetarium, Rochester Museum and Science Center, 657 East Ave., 14603, (716) 271-4320, 65’ dome theater (Zeiss Mark VI projector), exhibits, observatory (12.5" reflector). Open daily in summer. Program info. line: 442-7171.

Schenectady: Schenectady Museum and Planetarium, Nott Terrace Heights, 12308, (518) 382-7890, 30’ dome theater (Spitz A3P), laser shows, exhibits, tours. Open Daily in summer except Monday.

Staten Island: Wagner College Planetarium, 631 Howard Ave., Grymes Hill, 10301, (718) 390-3432, Open by reservation only.

Syracuse: Discovery Center of Science & Technology, 321 South Clinton St., 13202, (315) 425-9068, 24’ dome planetarium (Apollo Viewlex projector), exhibits, public observing. Open daily in summer. Program info. line: 425-0747.

Troy: The Junior Museum, 282 5th Ave., 12182, (518) 235-2120, 12’ dome theater (custom made projector), exhibits, tours, displays. Open daily in summer.

Yonkers: Andrus Planetarium, 511 Warburton Ave., 10701, (914) 963-4550, 40’ dome theater (Zeiss M1015), exhibits, workshops. Open Wed.-Sun.

NORTH CAROLINA

Chapel Hill: Morehead Planetarium, CB# 3480, E. Franklin St., Univ. of North Carolina, 27599-3480, (919) 962-1236, 68’ dome theater (Zeiss VI), observatory (24" Cassegrain), Cinema 360°, exhibits. Open daily in summer. Program info. line: 549-6863.

Charlotte: Discovery Place/Nature Museum, 301 North Tryon St., 28202, (704) 372-6261, Planetarium, OMNIMAX® theater.

Durham: North Carolina Museum of Life & Science, 433 Murray Ave., 27704, (919) 220-5429, Exhibits, space artifacts. Open daily in summer.

Greensboro: Edward Zane Planetarium, The Natural Science Center, 4301 Lawndale Dr., 27408, (919) 288-3769, 40’ dome theater (Spitz 512), exhibits, solar observatory. Open daily in summer.

Greensboro: Three College Observatory, Dept. of Physics and Astronomy, Univ. of North Carolina-Greensboro, 27412, (919) 334-5669, Observatory (32" reflector). Open by reservation only. Not open in July & Aug. Program info. line: 334-5844.

Hickory: Catawba Science Center, 243 3rd Ave. NE, P.O. Box 2431, 28603, (701) 322-8169, Exhibits, Starlab planetarium. Open Tues.—Sun.

Hudson: Caldwell Community College Planetarium, 1000 Hickory Blvd., 28638, (704) 726-2200, 20’ dome theater. Open by reservation only.

Lumberton: Robeson Science & Technology Center, Hwys. 72 & 711, P.O. Drawer 2909, 28359, (919) 671-6015, 30’ dome theater (Spitz A3PR), observatory (6" reflector), shows, exhibits. Open daily in summer except July.

Rocky Mount: Rocky Mount Planetarium, Children’s Museum, 1610 Gay St., 27804, (919) 972-1167, Planetarium open by reservation only.

Salisbury: Margaret C. Woodson Planetarium, 1636 Parkview Circle, 28144, (704) 636-3462, Exhibits, observatory. Open Mon.—Fri. & by reservation on Sat. and Sun. evenings.

Winston-Salem: Hanes Planetarium, Nature Science Center, 1 Museum Dr., 27104, (919) 767-6730, 50’ dome theater (Spitz 512), exhibits, observatory. Open daily in summer. New planetarium opening this fall.

NORTH DAKOTA

Grand Forks: Arthur P. Anderson Atmospherium, Univ. of North Dakota, P.O. Box 8216, University Station, 58202, (701) 777-2791, 40’ dome planetarium (Digistar projector). Open daily in summer.

Minot: Minot State Univ. Observatory, 500 University Ave. West, 58702-5002, (701) 857-3071, Observatory (16" scope). Public nights on occassional Thurs. Not open in summer.

Valley City: Valley City State Univ. Planetarium, Valley City State Univ., 58072, (701) 845-7334, 24’ dome theater (Spitz 512A). Open by reservation only.

OHIO

Bay Village: Schuele Planetarium, 28728 Wolf Rd., 44140, (216) 835-9912, Open Sun. only.

Canton: Hoover-Price Planetarium, McKinley Museum, 800 McKinley Monument Dr., 44701, (216) 455-7043, 25’ dome theater (Spitz A3P), exhibits, tours. Open daily in summer.

Cincinnati: Cincinnati Museum of Natural History and Planetarium, 1720 Gilbert Ave., 45202, (513) 345-8500, 32’ dome theater (Minolta Series II). Open daily in summer. Program info. line: 345-8505.

Cincinnati: Cincinnati Observatory, 3489 Observatory Place, 45208, (513) 321-5186, 16" and 11" refractors. Open by reservation only.

Cleveland: Cleveland Museum of Natural History, 1 Wade Oval Dr., University Circle, 44106, (216) 231-4600, Mueller Planetarium (30’ dome, Spitz A3P), exhibits, observatory (10.5" Warner and Swasey refractor). Open daily in summer.

Cleveland: NASA Lewis Visitor Center, 21000 Brookpark Rd. MS 8-1, 44135, (216) 433-2001, Visitor Center, exhibits, tours. Open daily in summer.

Cleveland: Warner & Swasey Observatory, Case Western Reserve Univ., 44106, (216) 368-3728.

Columbus: Center of Science and Industry, 280 East Broad St., 43215, (614) 228-2674, Exhibits, Batelle Planetarium theater (30’ dome). Open daily, daytime only.

Columbus: Ohio State Univ. Planetarium, 174 West 18th Ave., 43210, (614) 292-5554, 26’ dome theater.

Dayton: Dayton Museum of Natural History, 2629 Ridge Ave., 45414, (513) 275-7431, 50’ dome planetarium (Digistar projector), exhibits, observatory (20" scope). Open daily.

Delaware: Perkins Observatory, P.O. Box 449, 43015, (614) 363-1257, 32" reflector. Located on Route 23, 3 miles south of Delaware. Open Mon.-Fri. afternoons only. Public observing one evening per month, June-Oct.

Findlay: Newhard Planetarium, Findlay College, 1000 N. Main St., 45840, (419) 424-4533, 24’ dome theater (Goto S-3 projector).

Granville: Swasey Observatory, Denison Univ., 43023, (614) 587-6311, Observatory (9" telescope). Open evenings by reservation only.

Kent: Kent State University Planetarium, Physics Deptartment, 44242, (216) 672-2771, 40’ dome theater. Open by reservation only. Special public shows Oct. 9, 11, & 12.

Sylvania: Copernicus Planetarium, Lourdes College, 6832 Convent Blvd., 43560-2898, (419) 885-3211, 24’ dome theater, exhibits, public observing. Open Mon.-Sat. during academic year. Not open in summer.

Toledo: Ritter Planetarium and Brooks Observatory, Univ. of Toledo, 2801 W. Bancroft St., 43606, (419) 537-4641, 40’ dome theater, observatory (1-meter telescope), exhibits. Open Fri., Sat, & Sun.

Wapakoneta: Neil Armstrong Air and Space Museum, I-75 and Bellefontaine St., 45895, (419) 738-8811, 60’ dome theater, exhibits, tours. Open daily in summer.

Westerville: North American Astrophysical Observatory, Otterbein College, 43081, (614) 898-1516, 320’ by 71’ radio telescope. Open by reservation only.

Wilmot: Wilderness Center Planetarium, 9877 Alabama Ave., S.W., P.O. Box 202, 44689-0202, (216) 359-5235, 12’ dome theater (Techline). Open daily in summer.

Youngstown: Ward Beecher Planetarium, Youngstown State Univ., 44555-0001, (216) 742-3136, 40’ dome theater, laser shows, observatory (14" telescope). Open by reservation only.

OKLAHOMA

Fort Sill: Fort Sill Planetarium, Target Acquisition Dept., 73503, (405) 351-6616, Only planetarium in the Army. Open by reservation only.

Oklahoma City: Kirkpatrick Planetarium, OMNIPLEX Science Museum, 2100 N.E. 52nd, 73111, (405) 424-5545, 40’ dome theater (Minolta MS10), observatory (8" and 16" scopes), exhibits. Open daily in summer.

OREGON

Bend: Pine Mountain Observatory, Univ. of Oregon, Bend-Burns Star Route, 97702, (503) 382-8331, 32" and 24" telescope. Open by reservation only.

Eugene: Lane ESD Planetarium, 2300 Leo Harris Parkway, 97401, (503) 689-6500, 40’ dome theater (Viewlex Minolta IIB), observatory (16" Cassegrain), exhibits. Open Wed.-Sun.

Gresham: Mt. Hood Community College Planetarium, 26000 S.E. Stark St., 97030, (503) 667-7297, 30’ dome theater, observatory (6" solar telescope). Planetarium closed June-Sept.

Oregon City: Haggart Observatory, c/o John Inskeep Environmental Learning Center, P.O. Box 5162, 97045, (503) 657-8400, 24" telescope. Public nights every clear Wed., Fri., and Sat. Located at Clackamas Community College.

Portland: Oregon Museum of Science & Technology/Kendall Planetarium, 4015 SW Canyon Rd., 97221, (503) 274-4553, 40’ dome theater (Goto), exhibits. Open daily in summer. Program info. line: 228-STAR.

Salem: Chemeketa Community College Planetarium, 4000 Lancaster Dr., N.E., P.O. Box 14007, 97309, (503) 399-5248, 35’ dome theater (Spitz 512). Not open in summer. Program info. line: 399-5161.

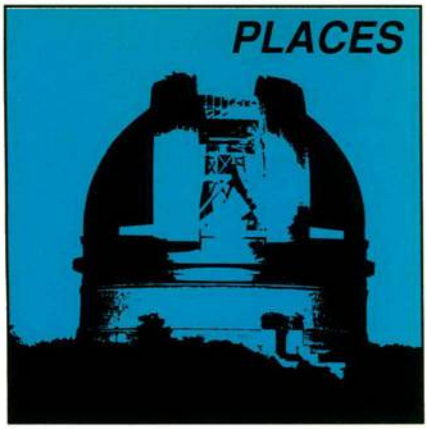
PENNSYLVANIA

Allentown: Joseph Grady Planetarium, 620 East Rock Rd., 18103, (215) 797-3476, 23’ dome theater (Spitz A3P), observatory (12.5" Cassegrain). Open weekends and by reservation. Program info. line: 967-1991

Clarion: Pierce Planetarium, Clarion Univ., 335 Peirce Science, 16214, (814) 226-1881, 40’ dome theater (Spitz), exhibits. Not open in summer.

Edinboro: Observatory and Planetarium, Edinboro Univ., 16444, (814) 732-2469, 24’ dome theater, observatory (16" SCT). Open by reservation only.

Erie: Erie Historical Museum and Planetarium, 356 West 6th St., 16507, (814) 453-5811, Open Tues.-Sun.



Harrisburg: State Museum of Pennsylvania Planetarium, 3rd and North Streets, Box 1026, 17108-1026, (717) 783-9914, 30′ dome theater (Spitz A3P), exhibits. Open daily in summer except Monday.

Lancaster: North Museum Planetarium, Franklin & Marshall College, P.O. Box 3003, 17604-3003, (717) 291-3941, 40′ dome theater, exhibits, observatory (11" refractor and 16" reflector). Open Wed.-Sun. only. Program info. line: 291-4315.

Latrobe: Observatory, St. Vincent College, 15650, (412) 539-9761, Public observing Sun. nights only by reservation.

Lewisburg: Bucknell Univ. Observatory, Dept. of Physics, 17837, (717) 524-1207, 10" Clark refractor. Open by reservation only.

Lock Haven: Ulmer Planetarium, Lock Haven Univ., 17745, (717) 893-2075, 30′ dome theater. Open by reservation only. Not open in summer.

New Wilmington: Westminster College Planetarium, Physics Dept., 16172, (412) 946-7200, 24′ dome theater (Spitz 512), observatory (14" Cassegrain). Open by reservation only.

Philadelphia: Franklin Institute, 20th and the Parkway, 19103, (215) 448-1157, Fels Planetarium (65′ dome), Tuttleman Omniverse Theater (76′ dome), observatory (24" Fecker reflector and 10" Zeiss refractor). Open daily. Program info. line: 448-1200.

Philadelphia: Univ. of Pennsylvania Observatory, Astronomy Dept., David Rittenhouse Laboratory, 33rd and Walnut St., 19104, (215) 898-8176, Open Mon. & Thurs. evenings only.

Pittsburgh: Allegheny Observatory, 159 Riverview Ave., Univ. of Pittsburgh, 15214, (412) 321-2400, Observatory (30" & 13" refractor, & 30" reflector), tos. Open April thru October Thurs. and Fri. evenings by reservation only.

Pittsburgh: Carnegie Science Center, One Allegheny Square, 15212-5850, (412) 237-3400, Henry Buhl Jr. Planetarium with 50′ dome interactive theater (Digistar projector), OMNIMAX® theater, exhibits, observatory (16" automated reflector with CCD camera).

Reading: Reading School District Planetarium, 1211 Parkside Dr. South, 19611-1441, (215) 371-5854, 40′ dome theater (Spitz A4), exhibits. Open Mon.-Fri., public shows at 1:00 p.m. only.

Scranton: Everhart Museum Planetarium, Nay Aug Park, 18510, (717) 346-8370, Open Tues.-Fri. by reservation.

Shippensburg: Roy Diebert Planetarium, Shippensburg Univ., 17257, (717) 532-1491, 30′ dome theater (Spitz APu). Not open in summer.

Villanova: Univ. Observatory, Mendel Hall, Villanova Univ., 19085, (215) 645-4820, 14" telescope. Open by reservation only.

West Chester: West Chester State Univ. Planetarium, Dept. of Geology & Astronomy, Rosedale and South Church Streets, 19383, (215) 436-2721, 33′ dome planetarium, observatory (12" scope). Open by reservation only.

Williamsport: Detwiler Planetarium, Lycoming College, 17701, (717) 321-4284, 30′ dome theater (Spitz A3P). Open by reservation only.

PUERTO RICO

Arecibo: Arecibo Radio Observatory, 00612, (809) 878-2612.

RHODE ISLAND

Charlestown: Frosty Drew Observatory, Ninigret Park, P.O. Box 160, 02813, (401) 364-9508, 7" refractor. Open Fri. evenings only.

Middletown: Middletown Planetarium, Gaudet School, Aquidneck Ave., 02840, (401) 846-6395, 30′ dome theater, public observing. Open by reservation only.

Providence: Cormack Planetarium, Museum of Natural History, Roger Williams Park, 02907-3600, (401) 785-9450, 24′ dome theater (Spitz A1), observatory (6" reflector), exhibits, tours. Open Sat. & Sun. 1:00 & 3:00 p.m. and June—Sept. Tues. & Thurs. 1:00 p.m. Program info. line: 785-9457.

Providence: Ladd Observatory, 210 Doyle Ave., 02906, (401) 863-2314, 12" Brashear refractor. Public observing Wed. evenings.

Warwick: Observatory, Community College of Rhode Island, 400 East Ave., 02886, (401) 728-4171, 14" telescope. Not open in summer.

SOUTH CAROLINA

Columbia: Gibbes Planetarium, 1112 Bull St., 29201, (803) 799-2810, 26′ dome theater (Minolta MS10). Public shows Sat. and Sun. Program info. line: 254-STAR.

Columbia: Melton Memorial Observatory, Univ. of South Carolina, Dept. of Physics & Astronomy, 29208, (803) 777-6466, Observatory (16" f/19 Cassegrain). Open clear Monday nights 9:30 to 11pm.

Florence: Florence Air and Space Museum, U. S. Highway 301, North Airport Entrance Rd., 29503, (803) 665-5118.

Florence: Planetarium and Observatory, Francis Marion College, P.O. Box 100547, 29501-0547, (803) 661-1250, 33′ dome theater, observatory (14" telescope). Open 2nd and 4th Sundays only.

Greenville: Roper Mountain Science Center & Daniel Observatory, 504 Roper Mountain Rd., 29615, (803) 281-1188, 50′ dome planetarium (Digistar projector), observatory (23" Clark refractor). Open Fri. evenings by reservation.

Orangeburg: Stanback Museum and Planetarium, P.O. Box 7636, 29117, (803) 536-8711, 40′ dome theater (Minolta IIB), exhibits. Not open in summer.

Rock Hill: Settlemyre Planetarium, Museum of York County, 4621 Mt. Gallant Rd., 29730, (803) 329-2121, 30′ dome theater, exhibits, public observing. Open daily in summer.

TENNESSEE

Brentwood: Dyer Observatory, 1000 Oman Dr., Vanderbilt Univ., 37027, (615) 373-4897, Observatory (12" and 24" reflectors). Public nights June 11 and July 2.

Chattanooga: Clarence T. Jones Observatory, Univ. of Tennessee at Chattanooga, Dept. of Physics and Astronomy, 37403, (615) 755-4546, 22.5" reflector, 25′ dome planetarium. Open Fri. evenings.

Kingsport: Bays Mountain Planetarium and Nature Center, 853 Bays Mountain Park Rd., 37660, (615) 229-9447, 40′ dome theater (Spitz/Goto), observatory (8" refractor), exhibits, solar observing every Sunday afternoon. Open daily in summer.

Knoxville: East Tennessee Discovery Center/Akima Planetarium, P.O. Box 6204, 516 Beaman St., 37914-0204, (615) 637-1121, 30′ dome theater, exhibits. Open daily in summer, daytime only.

Memphis: Memphis Pink Palace Museum and Planetarium, 3050 Central Ave., 38111, (901) 320-6320, 50′ dome theater (Minolta), observatory (20" reflector), exhibits, workshops. Open daily in summer.

Nashville: Campus Observatory, Vanderbilt Univ., P.O. Box 1803, Station B, 37235, (615) 373-4897, Observatory (6" refractor). Public nights June 8, June 26, July 7, Sept. 3, Oct. 2, and Oct. 16.

Nashville: Sudekum Planetarium, Cumberland Science Museum, 800 Ridley Blvd., 37203, (615) 862-5160 x13, 40′ dome planetarium (Spitz 512), exhibits, laser shows. Open daily in summer.

TEXAS

Amarillo: Don Harrington Discovery Center, 1200 Streit Dr., 79106, (806) 355-9547, 40′ dome theater (Spitz 512A), Traxx Heliostat, Cinema 360°, exhibits. Open daily in summer except Monday.

Dallas: Richland College Cosmic Theater & Planetarium, 12800 Abrams Rd., 75243, (214) 238-6038, 40′ dome theater, laser shows, public observing. Open Fri. & Sat. evenings and Sun. afternoons. Program info. line: 238-6013.

Dallas: St. Mark's School of Texas Planetarium, 10600 Preston Rd., 75230, (214) 363-6491, 30′ dome theater (Spitz A3P projector), observatory (16" Maksutov). Open by reservation only.

Dallas: The Science Place Planetarium, P.O. Box 151469, 75315-1469, (214) 428-8351, 24′ dome theater, exhibits. Open daily in summer.

El Paso: El Paso Planetarium, 6531 Boeing Dr., 79925, (915) 779-4316, 40′ dome theater (Spitz 512A), exhibits, starlab. Open by reservation only. Program info. line: 774-4317.

El Paso: Insights, El Paso Science Center, 303 N. Oregon St., 79901, (915) 542-2990.

Ft. Davis: McDonald Observatory, W. L. Moody Visitor's Center, P.O. Box 1337, 79734, (915) 426-3640, 107", 82", 36" and 30" telescopes. Open daily in summer. Public observing Tues., Fri. & Sat. evenings. Viewing through 107" on one Wednesday per month near full moon.

Ft. Worth: Noble Planetarium, 1501 Montgomery St., 76107, (817) 732-1631, 30′ dome planetarium (Spitz A3P). Open daily in summer.

Houston: Burke Baker Planetarium, Houston Museum of Natural Science, One Hermann Circle Dr., 77030, (713) 639-4632, 50′ dome theater (Digistar projector), laser shows, IMAX® theater, George Observatory (36") and Brown Observatory (16"). Open daily in summer. Program info. line: 639-4600.

Houston: Lyndon B. Johnson Space Center, 2101 NASA Rd. 1, 77058, (713) 483-4321, Exhibits, tours. Open daily 9 a.m.-4 p.m.

Killeen: Central Texas College Planetarium, P.O. Box 1800, Hwy, 190 West, 76540, (817) 526-1288, 24′ dome theater (Spitz A3P), observatory (8" scope), tours. Open by reservation only.

Lake Jackson: Brazosport Nature Center Planetarium, 400 College Dr., 77566, (409) 265-3376, 30′ dome theater (Spitz A4), exhibits.

Lubbock: Moody Planetarium, Museum of Texas Tech. Univ., 4th and Indiana Ave., 79409, (806) 742-2432, 30′ dome theater. Open daily in summer.

Midland: Marian Blakemore Planetarium, Museum of the Southwest, 1705 W. Missouri, 79701-6516, (915) 683-2882, 40′ dome theater (Minolta Viewlex Series IV), laser shows, exhibits, tours. Open Sun. 2:00—3:30 p.m. and Tues. 7:00 p.m.

Nacogdoches: Stephen Austin State Univ. Planetarium, Physics & Astronomy Dept., P.O. Box 13044, 75962, (409) 568-3001, 30′ dome theater (Spitz 512 projector). Open by reservation only.

Odessa: Odessa Meteor Crater, 620 N. Grant, Suite 1204, 79761, (915) 332-1666, Walk-through crater 8 miles west and south of Odessa on US 80. Open daily.

San Angelo: Angelo State Univ. Planetarium, Angelo State Univ., 76909, (915) 942-2136, 50′ dome theater (Spitz 512A), exhibits. Open daily in summer. Program info. line: 942-2188

San Antonio: San Antonio College Planetarium, 1300 San Pedro Ave., 78212, (512) 733-2910, Open Sun. evenings. Closed July 15-Aug. 30. Program info. line: 733-2911.

Tyler: Hudnall Planetarium, Tyler Junior College, P.O. Box 9020, 75711, (214) 531-2312, 30′ dome theater, exhibits, public observing. Open 1st and 3rd Sundays in June and July.

Wichita Falls: Wichita Falls Museum & Art Center Planetarium, 2 Eureka Circle, 76308, (817) 692-0923, 26′ dome theater (Spitz A3P). Open Sat. & Sun. only.

UTAH

Ogden: Layton Ott Planetarium, Weber State College, 84408-2508, (801) 626-7907, 30′ dome theater (Spitz A4). Open by reservation. Program info. line: 626-6855.

Provo: Sarah Summerhays Planetarium, Brigham Young Univ., 492 ESC, 84602, (801) 378-2805, 24′ dome theater (Viewlex Venus), observatory (14" scope). Open Friday evenings only and by reservation. Program info. line: 378-5396.

Salt Lake City: Hansen Planetarium, 15 South State St., 84111, (801) 538-2104, 50′ dome theater (Digistar projector), exhibits, tours, star parties. Open daily.

VERMONT

Williston: Green Mountain Observatory II, P.O. Box 782, 05495, (802) 985-3269, Observatory (10" Scheifspiegler), public observing. Open by reservation only.

VIRGINIA

Arlington: Arlington Planetarium, 1426 North Quincy St., 22207, (703) 358-6017, 30′ dome theater (Spitz AH-RPY). Open by reservation only. Program info. line: 358-6070.

Ashland: Keeble Observatory, Randolph-Macon College, 23005, (804) 752-7344, Observatory (12" Cassegrain). Open by reservation only.

Charlottesville: Leander McCormick Observatory, Univ. of Virginia, P.O. Box 3818, 22903, (804) 924-7494, 26" Clark refractor. Public observing 1st and 3rd Friday of each month through summer.

Chesapeake: Chesapeake Planetarium, 300 Cedar Rd., 23320, (804) 547-0153, 30′ dome theater, observatory (14" scope). Thurs. evening shows.

Hampton: NASA Langley Research Center, Mail Stop 480, 23665, (804) 864-6000, Visitor Center, exhibits, tours by reservation. Open daily.

Harrisonburg: John C. Wells Planetarium, James Madison Univ., Miller Hall, 22807, (703) 568-6109, 30′ dome theater (Goto Mark II). Open by reservation only. Program info. line: 568-STAR.

Harrisonburg: M.T. Brackbill Planetarium, Eastern Mennonite College, 22801, (703) 432-4400, 30′ dome theater, observatory (8" scope). Open by reservation only. Not open in summer.

Newport News: Virginia Living Museum Planetarium, 524 J. Clyde Morris Blvd., 23601, (804) 595-1900, 30′ dome theater (Spitz A3P), observatory (14" scope), exhibits. Open daily in summer.

Richmond: Ethyl Universe Space Theater, Science Museum of Virginia, 2500 West Broad St., 23220, (804) 367-0211, 76′ dome theater (Digistar projector), OMNIMAX® films, exhibits. Open daily in summer. Program info. line: 367-0000.

Roanoke: Science Museum of Western Virginia/Hopkins Planetarium, Center in the Square, One Market Square, 24011, (703) 342-5710, 40′ dome theater (Spitz 512 projector), Cinema 360, exhibits, laser shows, public observing. Open daily in summer. Program info. line: 342-7876.

Virginia Beach: Virginia Beach City Public Schools Planetarium, 3080 South Lynnhaven Rd., 23452, (804) 431-4067, 40′ dome theater, observatory (Questar), exhibits. Not open in summer.

Wallops Island: NASA Wallops Flight Facility, 23337, (804) 824-1344, Visitor Center, exhibits, tours by reservation. Open daily in summer, 10 a.m.-4 p.m.

WASHINGTON

Bellevue: Bellevue Community College Planetarium, 3000 Landerholm Circle, 98007, (206) 641-2321, Open Mon.-Fri. by reservation.

Bellingham: Western Washington Univ. Planetarium, Physics Dept., 98225, (206) 676-3818, 24′ dome theater (Spitz A2), observatory (8" scope). Open by reservation only.

Goldendale: Goldendale Observatory, 1602 Observatory Dr., 98620-3315, (509) 773-3141, Observatory (24.5" telescope plus 2" to 18" portables).

Pullman: Planetarium, Washington State Univ., Dept. of Physics, 99163-3113, (509) 335-8518, 24′ dome theater (Spitz A3P), observatory (12" refractor). Open by reservation only.

Seattle: Willard W. Smith Planetarium, Pacific Science Center, 200 Second Ave., North, 98109, (206) 443-2001, 27′ dome theater (Spitz 512), exhibits, OMNIMAX® theater. Open daily in summer. Program info. line: 443-2920.

Spokane: Eastern Washington Science Center, Riverfront Park, 99202, (509) 359-6391, Exhibits, planetarium shows. Open daily.

WEST VIRGINIA

Charleston: Sunrise Planetarium, 746 Myrtle Rd., 25314, (304) 344-8035, 24′ dome theater (Spitz A3P), observatory (10" Schmidt-Cassegrain). Open 1st & 3rd Sat. 11:00 a.m. & 2:00 p.m. and 2nd & 4th Fri. 7:30 p.m.

Elkins: Flynn Planetarium, Davis and Elkins College, 100 Sycamore St., 26241, (304) 636-1900, 25′ dome theater (Goto Venus). Open by reservation only.

Green Bank: National Radio Astronomy Observatory, P.O. Box 2, 24922, (304) 456-2011, Exhibits, tours. Open daily in summer except June 1-10. Program info. line: 456-2209.

Hedgesville: Berkeley County Planetarium, Hedgesville High School, Rt. 1–Box 89, 25427, (304) 754-3354, Open by reservation during school year.

Parkersburg: Dwight O. Connor Planetarium, 2101 Dudley Ave., Parkersburg High School, 26101, (304) 420-9595, 27′ dome theater. Open by reservation only.

Wheeling: Benedum Natural Science Center, Oglebay Resort and Conference Center, 26003, (304) 243-4034, 40′ dome theater (Spitz 512a), observatory (4" refractor), laser shows, Cinema 360°. Open daily.

WISCONSIN

Eau Claire: L. E. Phillips Planetarium, Univ. of Wisconsin, 54702-4004, (715) 836-5731, 24′ dome theater (Spitz A3P). Open Sept.—June by reservation only.

Fall Creek: Hobbs Observatory, Beaver Creek Reserve, Route 2, Box 94, 54742, (715) 877-2787, 24" reflector. Open every clear Sat. night May to Oct.

La Crosse: Planetarium, Univ. of Wisconsin at La Crosse, Cowley Hall, 54601, (608) 785-8669, 24′ dome theater (Spitz A3P projector). Not open in summer.

Madison: UW Space Place, 1605 S. Park St., 53715, (608) 262-4779, Public astronomy lectures and childrens' workshops.

Madison: Washburn Observatory, Univ. of Wisconsin-Madison, 475 N. Charter, 53706-1582, (608) 262-3071, Observatory (15" refractor), UW Space Place, lectures, childrens' workshops. Open 1st & 3rd Wed. evenings of the month and every Wed. from June 15 to July 29. Program info. line: 262-WASH.

Menasha: UW Fox Planetarium, Univ. of Wisconsin-Fox Valley, 1478 Midway Rd., 54952, (414) 832-2600, 25′ dome theater (Spitz A3P). Public observing sessions by reservation only. Program info. line: 832-2848.

Milwaukee: Manfred Olson Planetarium, Univ. of Wisconsin at Milwaukee, 1900 East Kenwood, 53211, (414) 229-4961, 30′ dome theater (Spitz A3P). Not open in summer.

Stevens Point: Planetarium, Univ. of Wisconsin-Stevens Point, 740 Reserve St., 54481, (715) 346-2208, 25′ dome theater (Spitz A3P), observatory (16" SCT). Open Tues. & Wed. evenings.

Williams Bay: Yerkes Observatory, 373 W. Geneva St., P.O. Box 258, 53191-0258, (414) 245-5556. Largest refractor (40") in the world. Tours: from June-Sept.: open Sat. 1:30-4 p.m.; from Oct.-May: open Sat. 10-noon. Program info. line: 245-5555.

WYOMING

Casper: Casper Planetarium, 904 North Poplar St., 82601, (307) 557-0310, 30′ dome theater (Spitz A3P), exhibits. Open daily in summer.

Laramie: Univ. of Wyoming Planetarium, Dept. of Physics and Astronomy, Univ. Station, Box 3905, 82071, (307) 766-6150, 40′ dome theater (Spitz), observatory (16" Cassegrain). Open every Fri. during academic year.

Laramie: Wyoming Infrared Observatory, Univ. of Wyoming, Univ. Station, Box 3905, 82071, (307) 766-6150.

CANADA

ALBERTA

Calgary: Alberta Science Centre, 701–11 St. SW, T2P 2M5, (403) 221-3712, 65′ dome theatre (Zeiss Jena Universal projector), exhibits, observatory (8" Maksutov). Open daily in summer. Program info. line: 221-3700.

Calgary: Rothney Astrophysical Observatory, Physics Dept., Univ. of Calgary, T2N 1N4, (403) 220-5392, 1.8-metre telescope. Open by reservation only.

Edmonton: Edmonton Space & Science Centre, 11211–142 St., T5M 4A1, (403) 452-9100, 76′ dome planetarium (Zeiss Jena Cosmorama projector), IMAX® theatre, exhibits, Challenger Learning Centre, observatory (14" SCT). Open daily in summer. Program info. line: 451-7722.

Edmonton: Physics Dept. Observatory, Univ. of Alberta, T6G 2J1, (403) 492-5287, Observatory (14" and 12" scopes), exhibits. Not open in summer.

BRITISH COLUMBIA

Penticton: Dominion Radio Astrophysical Observatory, Windlake Rd., Box 248, V2A 6K3, (604) 493-2277, 26-metre radio dish, 600-metre synthesis array, exhibits, self-guided tours Sun. 2 to 5 p.m. Open daily, daytime only.

Vancouver: H.R. MacMillan Planetarium & Gordon Southam Observatory, 1100 Chestnut St., V6J 3J9, (604) 736-4431, 65′ dome theater (Zeiss Jena Universal), observatory (20" telescope). Open daily in summer. Program info. line: 736-3656.

Vancouver: Science World, 1455 Quebec St., V6A 3Z7, (604) 687-8414, Exhibits, OMNIMAX® theatre. Open daily in summer, daytime only. Program info. line: 687-7832.

Vancouver: Univ. of British Columbia Observatory, 2219 Main Mall, V6T 1W5, (604) 228-2802, 16" telescope. Open clear Sat. evenings. Call 228-6186 to confirm.

Victoria: Climenhaga Observatory, Dept. of Physics and Astronomy, Univ. of Victoria, V8W 3P6, (604) 721-7750, 20" telescope. Open by reservation only.

Victoria: Dominion Astrophysical Observatory, 5071 West Saanich Rd., V8X 4M6, (604) 363-0001, 1.85-metre reflector, exhibits, public observing Sat. evenings. Open Mon.-Fri. daytime only.

MANITOBA

Winnipeg: Lockhart Planetarium, 380 University College, U. of M., 500 Dysart Rd., R3T 2M8, (204) 474-9785, 26′ dome theater (Spitz A3P). Open by reservation only.

Winnipeg: Manitoba Planetarium, Museum of Man & Nature, 190 Rupert Ave., R3B 0N2, (204) 956-2830, 60′ dome theatre, exhibits. Open daily. Program info. line: 943-3142.

NOVA SCOTIA

Halifax: Burke-Gaffney Observatory, Saint Mary's Univ., B3H 3C3, (902) 420-5633, Observatory (16" Cassegrain), slide shows. Open Saturday evenings and also by reservation.

Halifax: Halifax Planetarium, Nova Scotia Museum, Summer St., B3H 3A6, (902) 429-4610, Located at Sir James Dunn Building, Dalhousie Univ.. Open by reservation only.

ONTARIO

Hamilton: McMaster Univ. Planetarium, 1280 Main St. West, L8S 4M1, (416) 525-9140, 24′ dome theatre. Open by reservation only.

Ottawa: National Museum of Science & Technology, 1867 St. Laurent Blvd., K1G 5A3, (613) 991-9219, Exhibits, Starlab planetarium, observatory (15" refractor). Public observing every Tuesday evening (in French) and every Wednesday and Thursday evening (in English) during July and August.

Richmond Hill: David Dunlap Observatory, P.O. Box 360, 123 Hillsview Dr., L4C 4Y6, (416) 884-9562, Observatory (74" reflector), tours. Open Tues. mornings and public observing Sat. evenings April—Oct., both by reservation only.

Sudbury: Science North Science Center, 100 Ramsey Lake Rd., P3E 5S9, (701) 522-3701, Exhibits, solar observatory with 17.5" heliostat, evening public observing. Open daily in summer.

Toronto: McLaughlin Planetarium, Royal Ontario Museum, 100 Queen's Park, M5S 2C6, (416) 586-5737, 75′ dome theatre, laser shows, exhibits. Open daily in summer. Program info. line: 586-5736.

Toronto: Ontario Science Centre, 770 Don Mills Rd., M4C 4M3, (416) 429-4100, 24′ dome theater (Zeiss), 15 exhibits, Challenger Learning Centre. Open daily in summer.

QUÉBEC

Montréal: Dow Planetarium, 1000, St. Jacques Ouest, H3C 1G7, (514) 872-4530, 65′ dome theater (Zeiss V), exhibits. Open daily. Alternating schedule of French and English programs.

Notre Dame Des Bois: Mont Megantic Observatory, Chemin de Lamontagne, J0B 2E0, (819) 888-2822, 63-inch reflector. Open daily in summer.

SASKATCHEWAN

Regina: Saskatchewan Science Centre, Winnipeg St. & Wascana Dr., P.O. Box 5071, S4P 3M3, (306) 352-5811, Interactive science exhibits. Open Tues.-Sun. and holiday Mondays, daytime only. Program info. line: 352-5811.

Saskatoon: Univ. of Saskatchewan Observatory, Physics Dept., S7N 0W0, (306) 966-6396, Observatory (6" refractor). Open Sat. evenings. Program info line: 966-6429.

MEXICO

Enseñada: Observatorio Astronómico Nacional, Carretera Tijuana-Enseñada Km. 103.5, Apartado Postal 877, BC, 22860.

Enseñada: Observatorio de San Pedro Martir, Instituto de Astronomía, Apartado Postal 877, BC, 22860, (706) 678-3448.

Monterrey: Centro Cultural Alfa, Apartado Postal 1177, NL, 64000, Phone: 83-785819, 76′ dome theater (Spitz STS), OMNIMAX® films, exhibits, public observatory.

ASTRONOMY ORGANIZATIONS

In North America

Amateur Satellite Observers, HCR 65, Box 261-B, Kingston, AR 72742, Jim Hale.

American Association of Variable Star Observers, 25 Birch St., Cambridge, MA 02138, Janet Mattei, (617) 354-0484. Founded 1911, 1,100 members.

American Astronomical Society, 2000 Florida Ave. N.W., Suite 300, Washington, D.C. 20009, Peter B. Boyce, (202) 328-2010.

American Lunar Society, P.O. Box 209, East Pittsburgh, PA 15112, Francis Graham, (412) 829-7455. Founded 1982, 94 members, Observatory with 7" refractor.

American Meteor Society, Dept. of Physics-Astronomy, SUNY — Geneseo, Geneseo, NY 14454, David Meisel. Founded 1911, 100 members. EMail: Bitnet MEISEL@GENESEO.

Association des Groupes d'Astronomes Amateurs, 4545 Pierre-de-Coubertin, C.P. 1000, Succ. M, Montréal, Québec, CANADA, H7V 3R2, Jean-Marc Richard, (514) 252-3038. Founded 1975. Umbrella organization of 30 astronomy clubs in Québec with total membership of 600.

Association of Lunar and Planetary Observers, P.O. Box 143, Heber Springs, AR 72543, Harry Jamieson, Membership Secretary, (501) 362-7264. Founded 1947, 600 members.

Astronomical Association of Northern California, 4917 Mountain Blvd., Oakland, CA 94619-3014, Don Stone, (510) 376-3007. Founded 1971. Umbrella organization of 22 clubs. Send SASE for 1992 Resource Guide.

Astronomical League, 6235 Omie Circle, Pensacola, FL 32504, Merry Edenton Wooten, (904) 477-8859. Founded 1948, 11,400 members.

Astronomical Society of the Pacific, 390 Ashton Ave., San Francisco, CA 94112, Andrew Fraknoi, (415) 337-1100. Founded 1889, 7,000 members. National organization of professional and amateur astronomers. Annual conference in Madison, Wisconsin, June 20 – 25 co-sponsored by ASTRONOMY magazine.

Astronomy Day Headquarters, Chaffee Planetarium, 54 Jefferson SE, Grand Rapids, MI 49503, Gary Tomlinson, (616) 456-3987. Founded 1973. Coordinates National Astronomy Day. Extensive Handbook available to assist clubs.

Aurora Alert Hotline, 25 Manley Dr., Pascoag, RI 02859, David A. Huestis, (401) 568-9370. Founded 1978, 100 members.

Earthwatch, Box 403, Watertown, MA 02272, Blue Magruder, (617) 926-8200. Founded 1971, 45,000 members. Sponsors scientific field research worldwide.

Group 70/Large Amateur Telescope Project, 2331 American Ave., Hayward, CA 94545, Denni Medlock, (510) 278-6563. Founded 1988, 150 members.

International Amateur-Professional Photoelectric Photometry, Dyer Observatory, Vanderbilt Univ., Nashville, TN 37235, Douglas Hall, (615) 833-8878. Founded 1980, 950 members. Daytime phone number: (615) 373-4897.

International Dark-Sky Association, 3545 North Stewart, Tucson, AZ 85716, David Crawford. Founded 1988, 1,000 members. Promotes awareness of light-pollution problem and its solutions. Literature available.

International Meteor Organization (North America), 181 Sifton Ave., Fort McMurray, Alberta, CANADA, T9H 4V7, Peter Brown, (403) 743-8625. Founded 1988, 600 members worldwide. Coordinates reports from meteor observers. Publishes bimonthly journal. Hosting International Meteor Conference July 3-6.

International Occultation Timing Association, P.O. Box 7488, Silver Spring, MD 20901, David W. Dunham, (301) 495-9062, 300 members.

International Planetarium Society, Hansen Planetarium, 15 South State St., Salt Lake City, UT 84111.

National Deep Sky Observers Society, 1607 Washington Blvd., Louisville, KY 40242-3539, Alan Goldstein, (502) 426-4399. Founded 1976, 100 members.

National Space Society, 922 Pennsylvania Ave. SE, Washington, D.C. 20003, Aleta Jackson, (202) 543-1900.

Problicom Sky Survey and Nova Patrol, 1940 Cotner Ave., Los Angeles, CA 90025, Ben Mayer, (213) 478-2524. Founded 1975, 200 members.

Royal Astronomical Society of Canada, 136 Dupont Street, Toronto, Ontario, CANADA, M5R 1V2, Rosemarie Freeman, (416) 924-7973. Founded 1890, 3,200 members. Local Centres across Canada. Send electronic mail via Internet to: ASC@VELA.ASTRO.UTORONTO.CA

Small Scope Observers Association, 4 Kingfisher Place, Audubon Park, NJ 08106, Robert Browning, (609) 547-9487. Founded 1986, 116 members.

Society for Scientific Exploration, P.O. Box 3818, Charlottesville, VA 22903, L.W. Frederick, (804) 924-4905.

Society of Amateur Radio Astronomers, 247 North Linden St., Massapequa, NY 11758, Vincent Caracci, (516) 798-8459. Founded 1981, 225 members. Annual convention June 8-10, Greenbank, WV.

Spaceweek National Headquarters, 1110 NASA Rd. 1, #100, Houston, TX 77058, (713) 333-3627.

Sunsearch Supernova Patrol, 14400 Kolin Ave., Midlothian, IL 60445, Steve H. Lucas, (708) 396-1499. Founded 1985, 25 members.

The Meteoritical Society, Dept. of Geological Sciences, Univ. of Tennessee, Knoxville, TN 37996. Founded 1933, 850 members.

The Planetary Society, 65 North Catalina Ave., Pasadena, CA 91106, Susan Lendroth, (818) 793-5100. Founded 1980, 125,000 members.

Webb Society (North America), 1440 S. Marmora Ave., Tucson, AZ 85713-1015, Ronald J. Morales, (602) 628-1077. Founded 1967, 330 members. Organization of deep-sky observers. Call 4 to 7 p.m. or on Sundays for information.

Western Amateur Astronomers, 163 Starlight Crest Dr., La Canada, CA 91011, Stephen Edberg.

World Space Foundation, P.O. Box Y, South Pasadena, CA 91030-1000, Jack Child, (818) 357-2878.

Young Astronaut Council, 1211 Connecticut Ave. NW, Suite 800 , Washington, D.C. 20036, T. Wendell Butler, (202) 682-1984.

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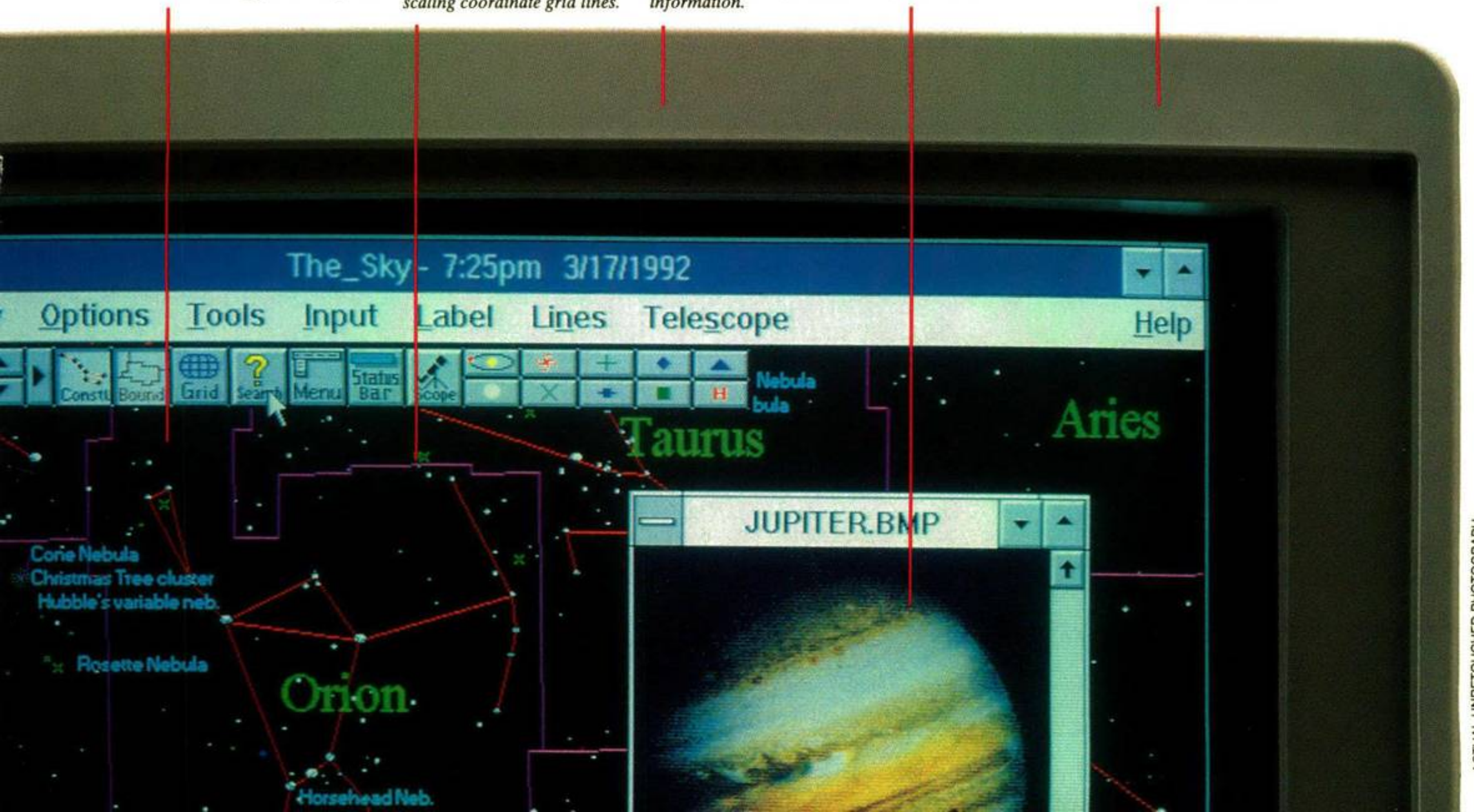
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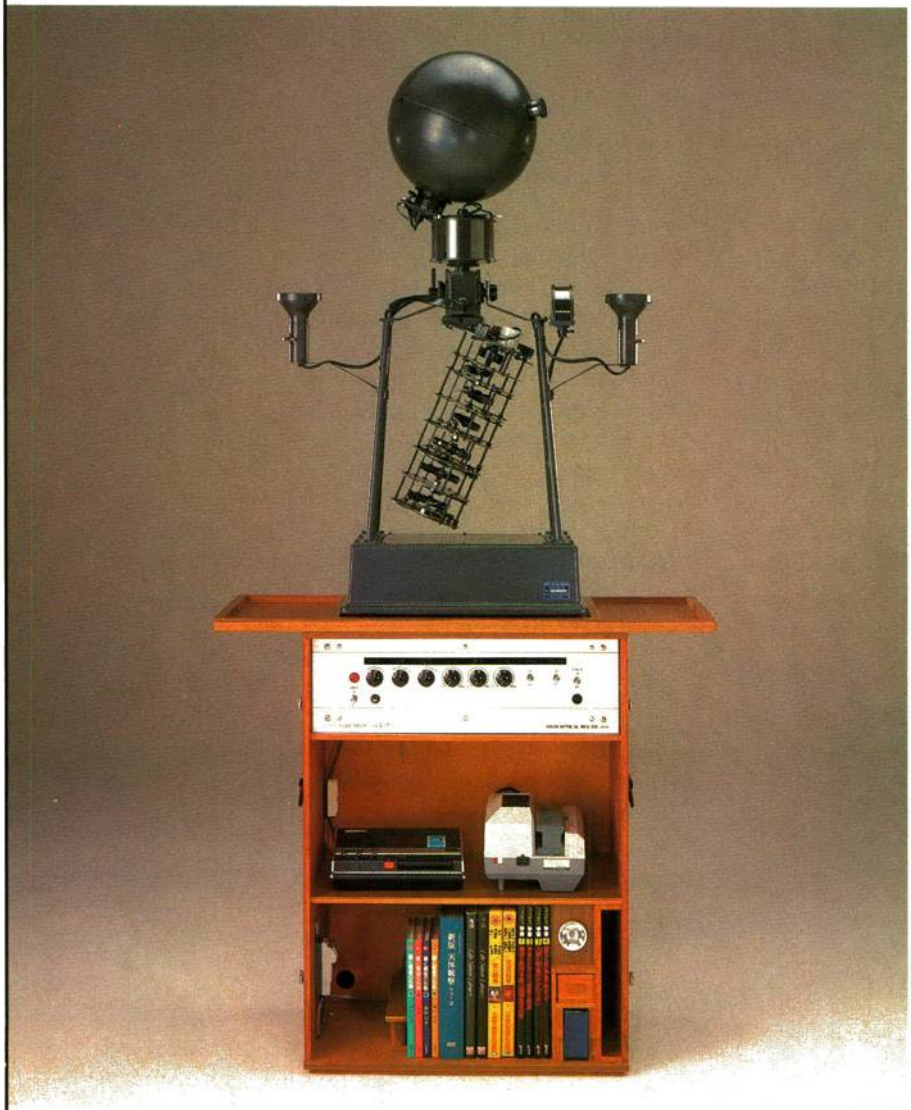

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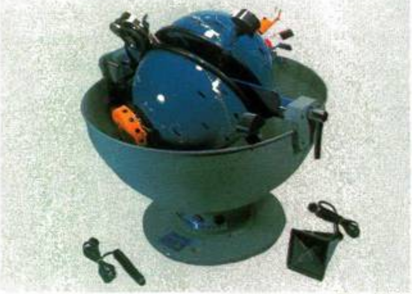

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